

W7111361

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PB 202 227-0

GROUND WATER RESEARCH PROGRAM

16060 --- 06/70

DETERMINATION OF POLLUTIONAL POTENTIAL OF THE
OGALLALA AQUIFER BY SALT WATER INJECTION

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87

1	Accession Number	2	Subject Field & Group	SELECTED WATER RESOURCES ABSTRACTS INPUT TRANSACTION FORM
	W71-11361		Ø5G, 5B, 4B	

5	Organization
	Environmental Protection Agency, Robert S. Kerr Water Research Center, Ada, Oklahoma, (FWQA)

6	Title
	DETERMINATION OF POLLUTIONAL POTENTIAL OF THE OGALLALA AQUIFER BY SALT WATER INJECTION,

10	Author(s)	16	Project Designation
	Leslie G. McMillion, Sr. Bruce W. Maxwell		16060 EPA Program 16060--06/70
		21	Note
			Available from the National Technical Information Service as PB 202227 \$9.00 in paper copy, \$8.05 in microfiche

22	Citation
	June 1970, 80p, 9 fig, 2 tab, 11 ref, 3 append

23	Descriptors (Starred First)
	*Injection wells, *Transmissibility, *aquifer characteristics, Groundwater, Water pollution control, Oklahoma, *Brine disposal, Storage Coefficient, Confined aquifers, Water pollution sources, Brines, Oil wells, Waste water disposal, Wells, Underground storage, Injection.

25	Identifiers (Starred First)
	*Ogallala aquifer, Texas County (OKla), Glorieta sandstone, Salt water injection, *Groundwater contamination, Disposal wells.

27	Abstract
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WR:102 (REV. JULY 1969) WRSIC		SEND TO: WATER RESOURCES SCIENTIFIC INFORMATION CENTER U.S. DEPARTMENT OF THE INTERIOR WASHINGTON, D. C. 20240	

WATER POLLUTION CONTROL RESEARCH CENTER
DETERMINATION OF POLLUTIONAL POTENTIAL OF THE

OGALLALA AQUIFER BY SALT WATER INJECTION

by

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for the

FEDERAL WATER QUALITY ADMINISTRATION

DEPARTMENT OF THE INTERIOR

**Program #16060
June 1970**

WATER POLLUTION CONTROL RESEARCH SERIES

The Water Pollution Control Research Reports describe the results and progress in the control and abatement of pollution in our Nation's waters. They provide a central source of information on the research, development, and demonstration activities in the Federal Water Quality Administration, in the U. S. Department of the Interior, through in-house research and grants and contracts with Federal, State, and Local agencies, research institutions, and industrial organizations.

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Report No. 100-1000
U. S. G. P. 1968
100-1000-1000

FEDERAL WATER QUALITY ADMINISTRATION
DEPARTMENT OF THE INTERIOR

Program 110000
June 1970

ABSTRACT

Field studies were conducted to determine whether contamination of the Ogallala Aquifer could result from the current practice of injection of oil-field brines into the Glorieta Sandstone, which lies 500 to 1,000 feet below the Ogallala in Texas County, Oklahoma--the study area.

The project was designed on the basis that for brines to move from the Glorieta to the Ogallala the potentiometric pressures in the Glorieta would have to be higher than water-level elevations of the Ogallala.

Since the hydraulic characteristics of the Glorieta Sandstone were needed for determining this fluid relationship, a technique was developed for making aquifer tests in brine disposal wells. The technique has application in certain water resources investigations and in situations similar to that of this study.

Key Words: Pollution, aquifer tests, Oklahoma, oil-field brines, Ogallala Aquifer, Glorieta Sandstone, injection, water quality, water levels, fluid pressures, coefficient of transmissibility, storage coefficient.

PREFACE

This report results from work conducted in or otherwise pertaining to Texas County in the Panhandle of Oklahoma. The effort was initiated to answer questions relative to the practice of salt water disposal by subsurface injection and the subsequent possibility of contaminating the area's principal water resource.

The work was done in cooperation with the Oklahoma Corporation Commission and is offered by the Federal Water Quality Administration as a member of the "Committee for Comprehensive Studies of Fresh Water in Western Oklahoma."

In addition to presenting data and recommendations upon which the Oklahoma Corporation Commission can base regulations concerning salt water disposal in Texas County, a technique is presented by which the problem can be approached in other states bordering the Oklahoma Panhandle and, indeed, many other areas of the country where similar problems exist.

The technique will be appropriate as part of a concerted effort by all states to monitor salt water and other waste disposal wells.

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CONCLUSIONS

1. The well-testing technique described in this report provides rapid and reliable results in determining static fluid pressures, levels, and densities in artesian aquifers. When used to determine the hydraulic characteristics of an aquifer the results must be considered approximate because of the effects of well loss, partial penetration of the aquifer by the disposal well, and variance in transmissibility with the vertical location of perforation.

The coefficient of transmissibility of the Glorieta Sandstone was estimated to be 4,000 gpd/ft and the storage coefficient 0.0001.

2. Static pressure levels of the Glorieta in Texas County were correlated using multivariate regression techniques and were expressed as a plane. Water levels in the Ogallala were correlated similarly. It was concluded from these analyses that the static pressure of the Glorieta was lower than water levels in the Ogallala by about 630 feet at the northwest corner of the County with this difference being reduced to zero near the southeast corner of the County.

3. Records of the Oklahoma Corporation Commission covering one township with approximately 250 well tests are adequate to describe generally the area's oil activities but do not provide conclusive evidence either to the presence or absence of a pollutorial potential to the Ogallala.

4. No natural possibility exists for waters in the Glorieta Sandstone to migrate into the Ogallala Aquifer except in the southeast corner of the County.

5. Waters from the Glorieta probably are discharged naturally east of this area as indicated by the proximity of Glorieta pressure heads to the land surface and the hydraulic gradient of the Glorieta determined by this study.

6. The potential of pollution to the Ogallala by current salt water disposal practices is low except near the southeast corner of the County. The potential with current disposal rates decreases rapidly with increased distance toward the northwest. This conclusion is based on the natural hydraulic relationship between the two formations with consideration for the alteration of these relationships by both salt water disposal and water-level reductions near pumping water wells.

RECOMMENDATIONS

Even though the conclusions of this report show a low pollutional potential to the Ogallala Aquifer which might result from the disposal of salt water into the Glorieta Sandstone, there are other considerations that must be evaluated in the interest of providing maximum long-term protection to water resources in Texas County, those areas which are near Texas County, and indeed areas everywhere when the potential for pollution exists. History has recorded many instances where practices were permitted, largely because of limited foresight, which later caused considerable damage to the environment. Such practices resulted in damages for which there was no practical economical remedy or no known scientific solution. Salt water "evaporation" pits and combined storm runoff and municipal sewerage systems fall into these categories.

Looking to the future, the Federal Water Quality Administration has prepared a Policy on Disposal of Wastes by Subsurface Injection. It is provided in its entirety in Appendix C. In relation to the Ogallala-Glorieta question, the policy encourages that such disposal be used only after it has been demonstrated as the best alternative in terms of environmental protection and then only on a temporary basis until better waste disposal practices can be developed. The policy encourages the use of subsurface waste disposal in this case for the overall planned management of ground water or related resources such as the use of waste brines for the secondary recovery of oil. It is therefore recommended that to the extent possible salt water disposal into the Glorieta Sandstone be discontinued in favor of using such brines as a resource for secondary oil recovery.

It is recommended that a greater percentage of the Glorieta be perforated in salt water disposal wells in order to reduce pressures in the injection tubing.

It is recommended that static water levels should be determined annually and correlated to evaluate the pollutional hazards.

It is recommended that the coefficients of transmissibility and storage determined by this study be refined by tests using fully penetrating injection wells and appropriate observation wells. These well tests should be made at locations adequate to describe geographical variation of these coefficients within the County.

It is recommended that the quality of water native to the Glorieta be determined so that an informed evaluation can be made of water quality changes which will result if salt water injection continues. These analyses are necessarily the basis of evaluating potential uses of and pollutional hazards to waters contained naturally in the Glorieta Sandstone.

INTRODUCTION

The Ogallala Aquifer is a major source of water in Colorado, Kansas, Nebraska, New Mexico, Oklahoma, and Texas. Water resources development in the Oklahoma Panhandle is largely dependent upon this ground-water supply.

In addition to municipal water requirements, water for the vast irrigated agriculture and oil production activities in the area is obtained from the Ogallala Aquifer. The vested interest of all these groups in water availability, quality, and methods of waste disposal sets the foundation of this study.

The Ogallala Formation underlies the surface in most of Texas County, Oklahoma, and ranges up to 600 feet in thickness. Another formation--The Glorieta Sandstone--lies below the Ogallala and is separated from it by 500 to 1,000 feet of material which generally consists of gypsum, shale, sandstone, and bedded salt. The Glorieta is about 200 feet thick (Irwin and Morton, 1969) and is composed mainly of very fine unconsolidated sand.

Oil-field brines are being disposed into the Glorieta Sandstone by injection through wells; there are more than 30 such disposal wells in Texas County.

During the past few years much concern has developed among fresh-water users that brine disposal into the Glorieta might ultimately result in salt water pollution of the Ogallala Aquifer. This concern has been based primarily on the belief that there are unplugged or inadequately plugged wells and exploration holes that penetrate both formations and could act as avenues for movement of salt water from the Glorieta to the Ogallala if appropriate hydraulic conditions exist or are created by brine injection operations. Also, there was concern that the Glorieta might contain water of a usable quality that would be deleteriously affected by brine injection into the Formation.

On November 7, 1969, a meeting was held at Goodwell in Texas County to collect views of all interested parties concerning salt water disposal into the Glorieta Formation and the effects this practice might have on fresh waters within the Ogallala Formation.

Following the Goodwell meeting, the "Committee for Comprehensive Studies of Fresh Water in Western Oklahoma" was established by the Governor of Oklahoma. The Chairman of the Committee appointed a Task Force Committee which included representatives from the Oklahoma Geological Survey, Oklahoma State University, Mid-Continent Oil and Gas Association, Texas County Irrigation and Water Resources Association, U. S. Geological Survey, Federal Water Quality Administration (Robert S. Kerr Water Research Center), and was headed by the Oklahoma Water Resources Board.

During the first meeting of the regular committee, the Regional Director, South Central Region, Federal Water Quality Administration, offered the services of his staff in making a six-month investigation of the problem.

This report covers the resulting investigation. While the project was conducted under the auspices of the Task Force Committee, it was done in cooperation with the Oklahoma Corporation Commission, the agency that will establish and administer any rules and regulations that may be suggested as a result of this or any related investigation.

The Ogallala Formation underlies the surface in most of Texas County, Oklahoma, and ranges up to 600 feet in thickness. Another formation--the Clinton Sandstone--lies below the Ogallala and is separated from it by 500 to 1,000 feet of material which generally consists of gypsum, shale, sandstone, and bedded salt. The Clinton is about 100 feet thick (Lavin and Horton, 1959) and is composed mainly of very fine unconsolidated sand.

Oil-field brines are being disposed into the Clinton Sandstone by injection through wells; there are now more than 50 such disposal wells in Texas County.

During the past few years much concern has developed among local water users that brine disposal into the Clinton might adversely result in salt water pollution of the Ogallala Aquifer. This concern has been based primarily on the belief that there are upwardly or laterally pinched wells and exploration holes that penetrate both formations and could act as avenues for movement of salt water from the Clinton to the Ogallala. It is apparent that hydraulic conditions exist or are created by brine injection operations. Also, there was concern that the Clinton might contain water of a suitable quality that would be detrimentally affected by brine injection into the formation.

On November 7, 1969, a meeting was held at Goodwell in Texas County to obtain views of all interested parties concerning salt water disposal into the Clinton formation and the effects this practice might have on fresh waters within the Ogallala formation.

Following the Goodwell meeting, the "Committee for Comprehensive Studies of Fresh Water in Western Oklahoma" was established by the Governor of Oklahoma. The Chairman of the Committee appointed a Task Force Committee which included representatives from the Oklahoma Geological Survey, Oklahoma State University, Mid-Continent Oil and Gas Association, Texas County Investigation and Water Resources Association, U. S. Geological Survey, Federal Water Quality Administration (Robert S. Kerr Water Research Center), and was headed by the Oklahoma Water Resources Board.

TECHNICAL CONSIDERATIONS

The pollutional potential to the Ogallala of salt water disposal into the Glorieta can be evaluated only if the hydraulic relationships of both formations are understood in their present state and under future conditions where hydraulic relationships are altered by injection into or withdrawal from the formations. Realizing that the data needed for the existing conditions of the Ogallala have been collected and are available for Texas County in either published (Wood and Hart, 1967) or unpublished form, a principal task remaining for this undertaking was obtaining data relative to the Glorieta. Glorieta data would have to include hydraulic characteristics of the Formation as well as its static fluid pressures since these characteristics determine the increase in fluid pressures and horizontal extent of such changes which result from injection into the Formation. It was recognized that there would be considerable advantage to the development of a technique for obtaining these data by making tests in existing injection wells since the construction and testing of special test wells would involve not only considerable expenditures of money but also of time.

A technique by which these hydraulic characteristics could be determined would also be applicable in states surrounding the Oklahoma Panhandle as well as many areas across the country. In addition, the technique would be appropriate for monitoring not only salt water but other waste disposal wells.

Existing fluid pressures in the Glorieta Formation will be increased by the injection of salt water. This increase and its horizontal extent will be a function of injection rate and duration as well as the hydraulic characteristics of the Formation, as mentioned earlier. Water levels in the Ogallala will be lowered by pumping. The magnitude and extent of this decrease will be a function of that Formation's hydraulic characteristics as well as the rate and duration of pumping.

Hydraulic relationships favoring contamination will exist when the fluid pressure of the Glorieta exceeds that of the Ogallala at any point. Thus, for practical purposes, fluid pressures of the Glorieta should be maintained below those of the Ogallala.

Avenues of fluid flow must be present before contamination can occur even when these conditions exist. As mentioned above, fluid migration is possible through unplugged or inadequately plugged wells or exploration holes or natural connections through material separating the two formations. Solution cavities have been found in Texas, south of Texas County, Oklahoma, during coring for the Sanford Dam.

PROJECT GOALS

From the technical considerations of the problem, goals of the project were evident. It was obvious that rather extensive data should be collected and evaluated.

Specifically, the following aspects were designated as project goals:

1. Develop and demonstrate a technique by which static pressures and fluid levels in the Glorieta or similar formations can be determined along with the hydraulic characteristics of the formation. The technique should be appropriate to monitor salt water or other waste disposal wells.
2. Determine the relationship of fluid pressures in the Glorieta to water levels in the Ogallala.
3. Determine to what extent the Oklahoma Corporation Commission records for a selected township in Texas County can be useful in determining the following information:
 - a. Presence or absence of improperly abandoned or unplugged oil and gas tests and wells.
 - b. Information on surface casing and cementing programs of producing and abandoned oil and gas wells with respect to protection of fresh-water strata.
 - c. Relationship of surface casing to the base of the Ogallala Formation to determine adequacy of protection afforded the Ogallala.

PROJECT APPROACH

Corporation Commission Records

The most expedient method for locating information concerning those avenues of fluid migration caused by man would be from records of the Oklahoma Corporation Commission both in the headquarters office in Oklahoma City and in the Kingfisher District Office. To this end, one Township was selected in Texas County which appeared to be representative of salt water disposal and other oil field activities in this County.

Ogallala Water Levels

In order to determine the relationship between field pressures in the Glorieta and water levels in the Ogallala, it is imperative that an adequate description of both water levels and hydraulic characteristics of the Ogallala be gained.

Standard pumping tests and water table measuring techniques are adequate for this purpose. This information is available from the U. S. Geological Survey.

Glorieta Tests

The most important and complex portion of this work is associated with the determination of static fluid pressures and hydraulic characteristics of the Glorieta Formation.

The problem was approached using existing salt water disposal wells located so as to provide general coverage of Texas County. The general approach was to measure fluid heads by lowering a pressure sensing gauge into wells while making appropriate pressure and vacuum recordings at the well head. Static levels were measured in this way by allowing the fluid levels to stabilize or continue to the extent that projections could be made of the static level. Hydraulic characteristics were determined by an analysis of the changes in pressures that resulted from injection into the wells at constant rates and subsequent recoveries after injection had ceased.

The characteristic of a formation which describes its capacity for transmitting water is referred to as the coefficient of transmissibility. It is defined as the rate of flow of water in gallons per day that will pass through a vertical strip in the aquifer one-foot wide extending through its full saturated depth while under a hydraulic gradient of unity. The coefficient of transmissibility is equivalent to the coefficient of permeability of the formation multiplied by its saturated thickness and is expressed as gallons per day per foot (gpd/ft).

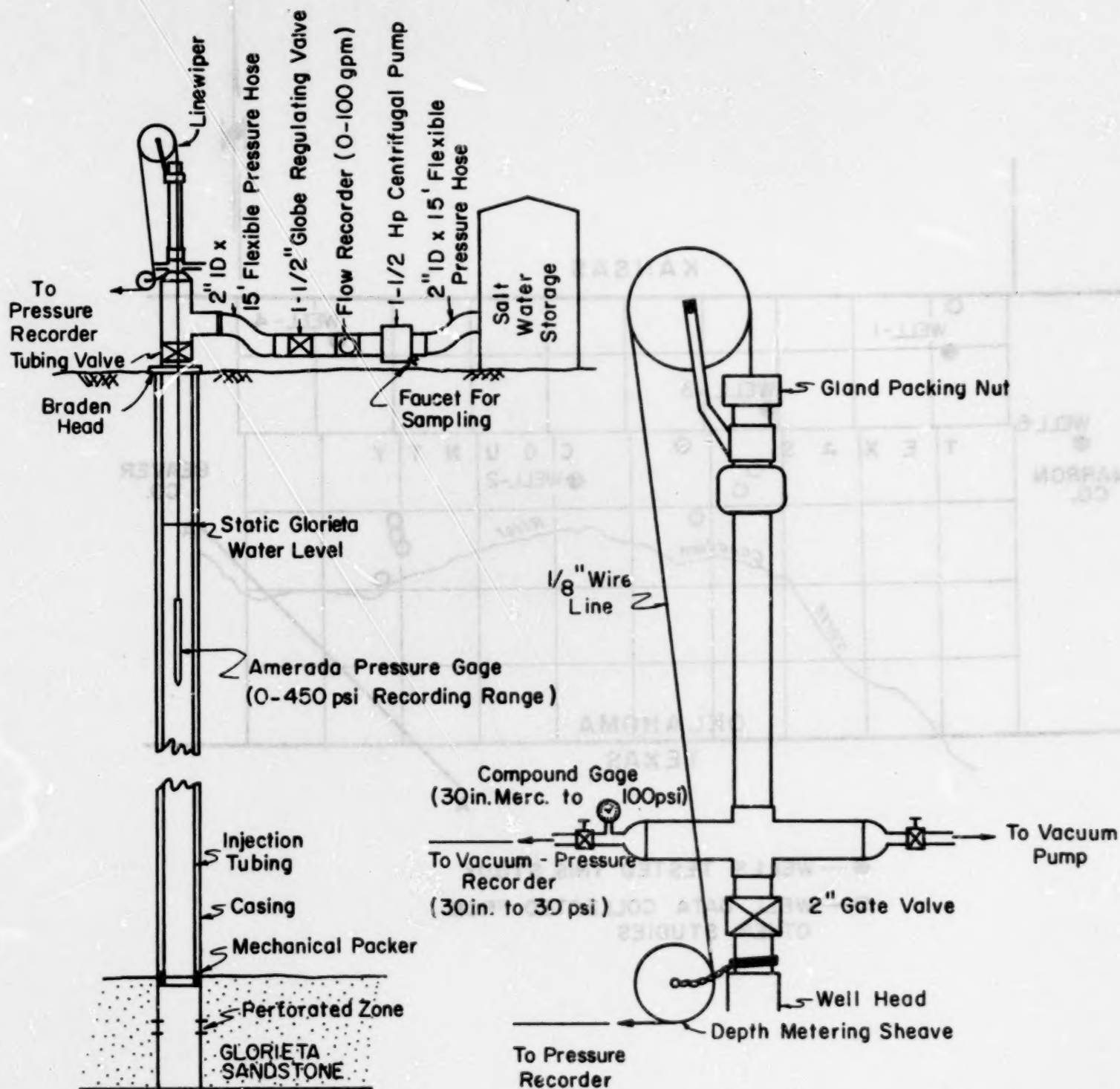
Field Procedures

Field procedures used in this investigation were designed to measure fluid pressures in the injection tubing and vacuum and pressure at the well head while accurately measuring and controlling injection rates.

The equipment used consisted of a gasoline-powered generator, lights, recorders, meters, and pumping units. Two panel trucks housed and transported the equipment. When conducting a test, the Amerada gauge, line wiper, etc., were installed on the well (Figure 1). All recording devices were operated in one vehicle, and the generators were operated in another. Vacuum pumps were connected to the well head equipment with rubber vacuum hose and operated at the well.

The procedure followed during the tests was as follows:

1. Pumping-metering equipment was installed between salt water storage tanks and the well. The Cities Service Klingsick well test (Well 2, Figure 2) used the metering and pumping system already installed by the company for normal operation.
2. With the valve in the well tubing closed, the line wiper was installed on the well head with the gate valve at the bottom of that apparatus closed to prevent accidental dropping of materials into the well. Vacuum and pressure sensing equipment are attached to the line wiper.
3. After the bottom valve of the line wiper and the well tubing valve were opened, the Amerada gauge was lowered into the well to a measured point below the static fluid level.
4. The well was closed in and evacuated with a vacuum pump. The vacuum in each well was reduced to about 26 inches of mercury.
5. Fluid levels were allowed to stabilize to the point that adequate projections of the static fluid level could be determined.
6. Injection into the well began, and the time was recorded. Injection at a constant rate continued along with recording the rise in fluid levels for a predetermined time.



DETAIL-LINEWIPER AND APPURTENANCES

FIGURE 1 - TYPICAL WELL TEST APPARATUS
GLORIETA SANDSTONE

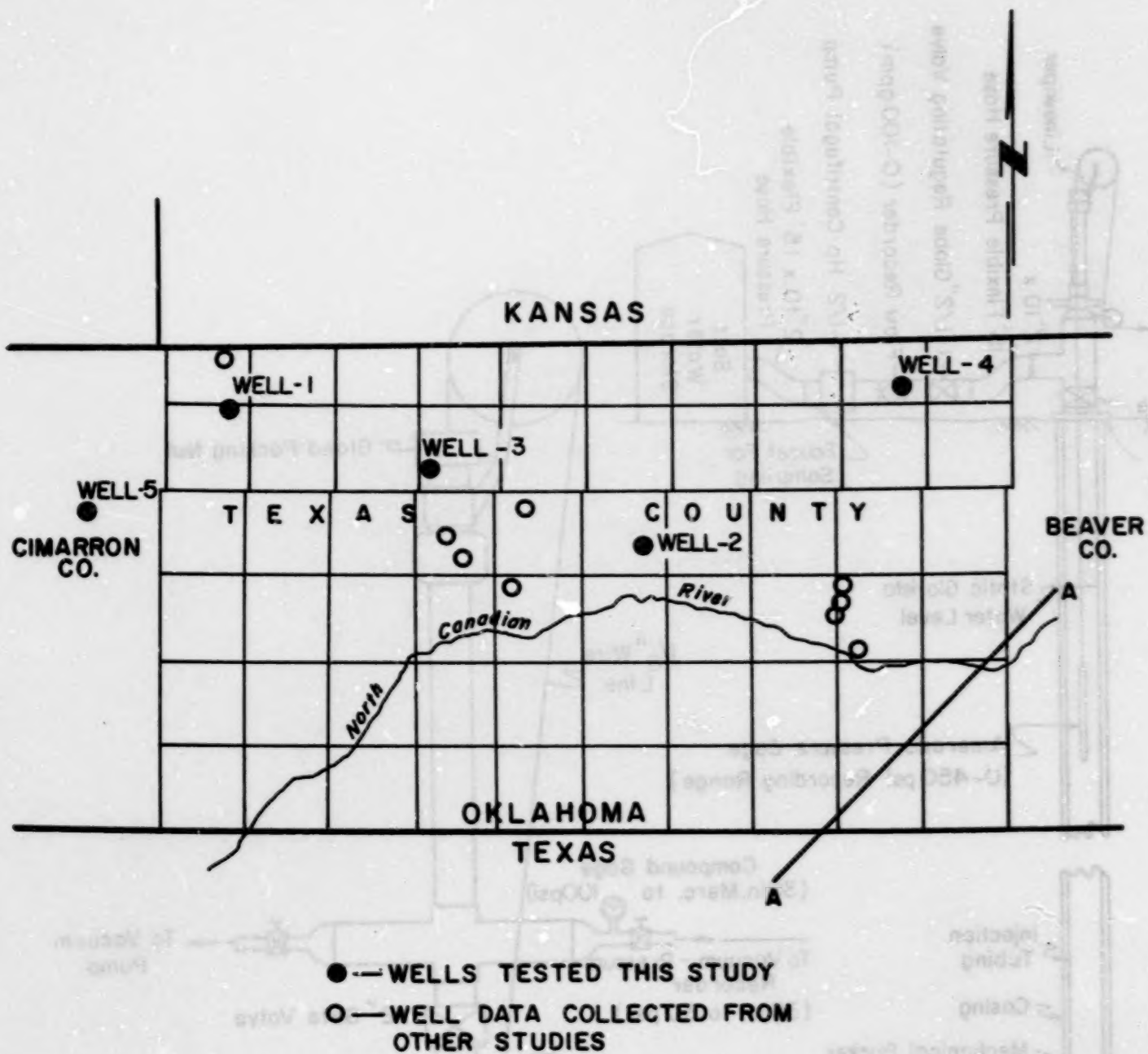


FIGURE 2 — LOCATION MAP

7. Injection was discontinued, and the time recorded. The fall in fluid levels was again recorded until conditions could be projected adequately or the change in levels was very slow.
8. In one case, to verify that water level determinations were accurate, the well was opened after the test so that verification could be made using a 500-foot electric water level measuring device.
9. A step test was conducted in Wells 3 and 4 (Figure 2).
10. Equipment was removed from well, and the well was evacuated before leaving the location.

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RESULTS

Field Tests

Recharge and recovery tests were made in Wells 1 through 4, shown on Figure 2, which are Glorieta salt water disposal wells. Additional tests were made on Wells 3 and 4 so that well losses could be calculated. Also, the static fluid level and density were determined for Well 5, which is located in Cimarron County. A summary of these tests is provided in Table 1. The test data are contained in Appendix A.

Fluid levels resulting from recharge-recovery tests are shown in Figures 3 through 6. It is very important to realize that these fluid levels represent pressures in the injection tubing and not those in the Glorieta Sandstone. Fluid pressures within the sandstone are lower due primarily to well losses through the well face and partial penetration effects resulting from only a part of the total length of the casing opposite the Glorieta being perforated.

Although the tests performed are quite adequate in determining static fluid levels of the Glorieta Sandstone, head losses make the determination of transmissibility problematical.

In order to make an estimate of the transmissibility of the Glorieta, step tests or variable injection rate tests were made on Wells 3 and 5. The approach involves estimating the coefficient of transmissibility from the specific capacity of the well. Specific capacity of an injection well is its intake rate per unit of pressure head increase; in this report it is expressed as gallons per minute per foot of head increase (gpm/ft).

From the step test data, well losses can be calculated according to the following equation (Jacob, 1946).

$$s_w = CQ^2$$

where s_w = well loss, ft

C = well loss constant, sec^2/ft^5

Q = injection rate, cfs

$$C = \frac{\Delta S^i / \Delta Q_i - \Delta S^{i-1} / \Delta Q_{i-1}}{\Delta Q_i + \Delta Q_{i-1}}$$

Partial penetration effects can be approximated and the specific capacity corrected according to the following equation (Turcan, 1963).

Table 1

Summary of Well Tests

<u>Well</u>	<u>Location</u>	<u>Test Date</u>	<u>Test Performed</u>
1. Robertson, Hall No. 1	Sec. 2, T5N, R10ECM (Texas County)	June 9, 1970	Recharge, Recovery, Static Level
2. Cities Service Klingsick A-2	Sec. 22, T4N, R15ECM (Texas County)	June 10, 1970	Recharge, Recovery, Static Level
3. Cities Service Hartman A-2	Sec. 20, T5N, R13ECM (Texas County)	June 12, 1970	Recharge, Step Test, Recovery, Static Level
4. Mid-American Pipeline Company SWD	Sec. 34, T6N, R18ECM (Texas County)	June 23-24, 1970	Recharge, Step Test, Recovery, Static Level
5. Chris Hunt SWD	Sec. 11, T4N, R8ECM (Cimarron County)	June 25, 1970	Static Level

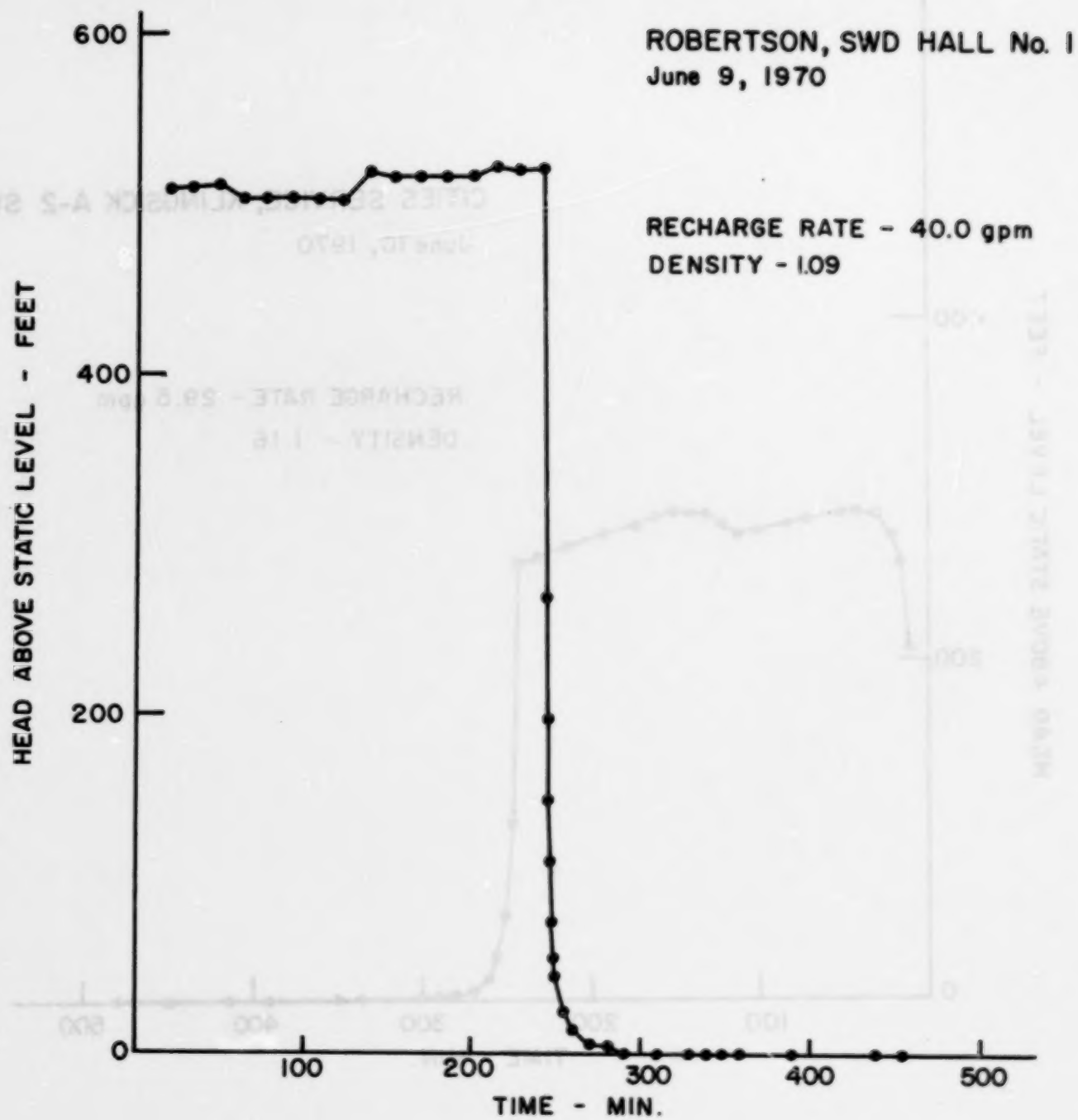


FIGURE 3 - RECHARGE AND RECOVERY TEST
GLORIETA SANDSTONE

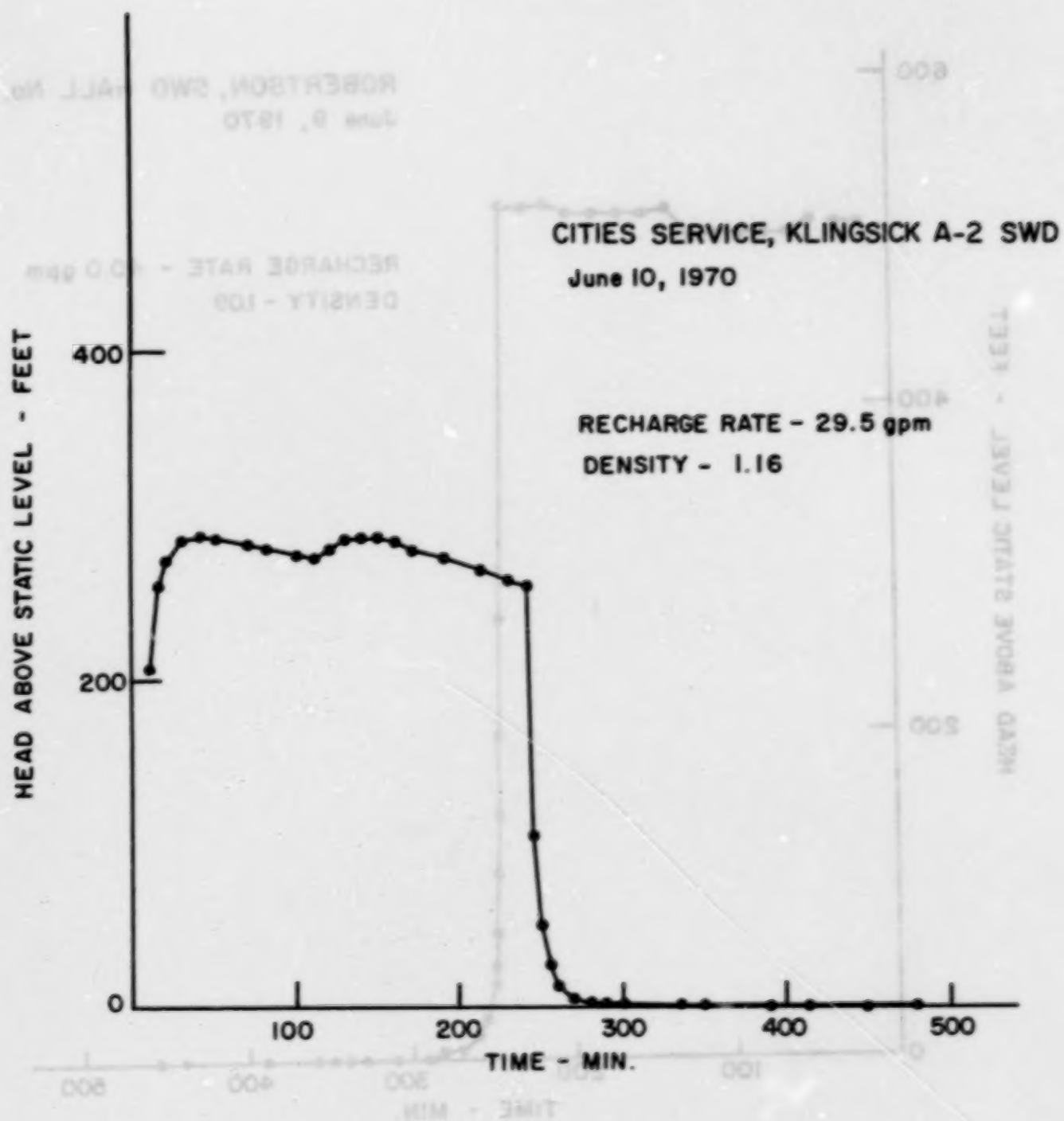


FIGURE 4 - RECHARGE AND RECOVERY TEST
GLORIETA SANDSTONE

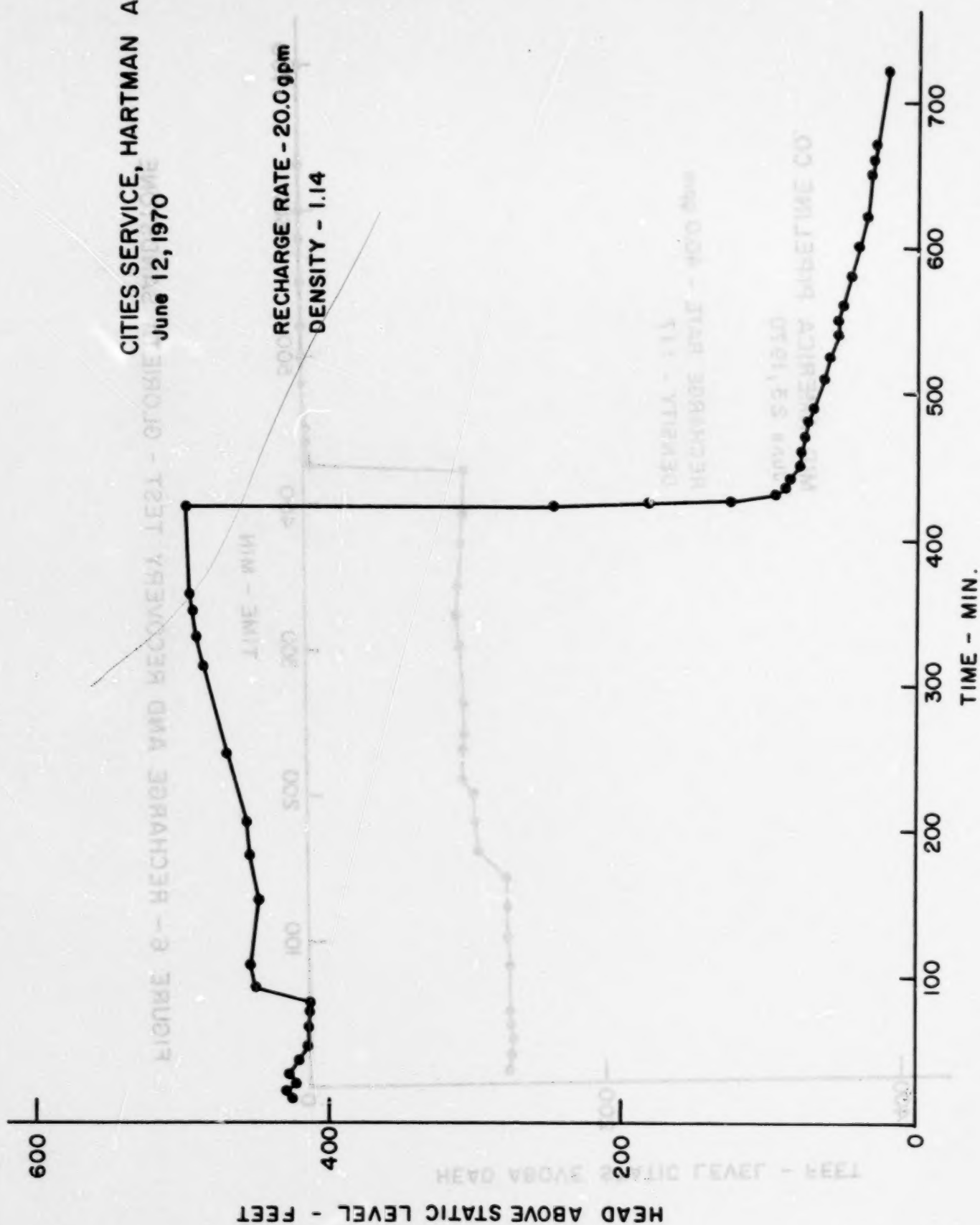


FIGURE 5 - RECHARGE AND RECOVERY TEST - GLORIETA SANDSTONE

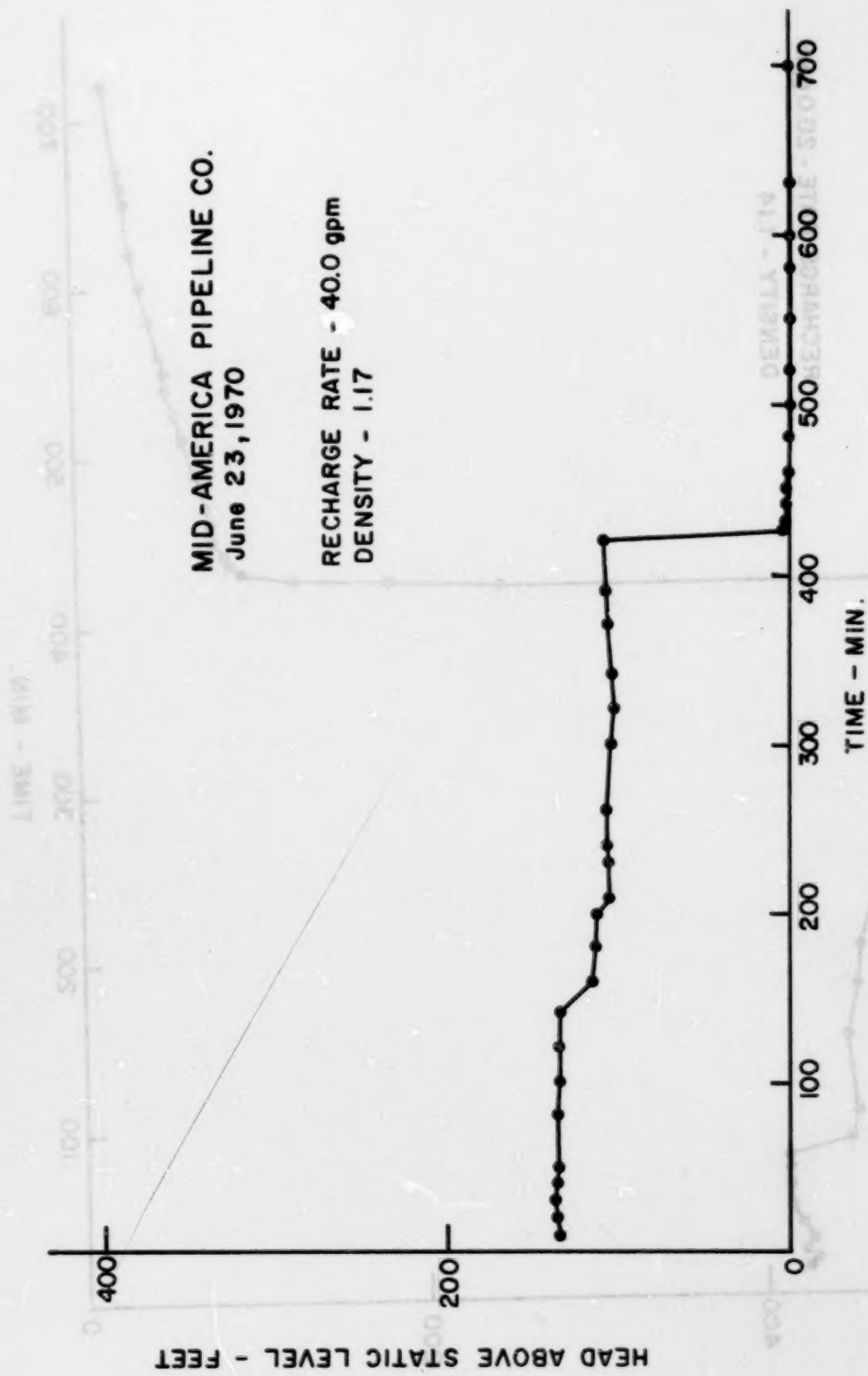


FIGURE 6 - RECHARGE AND RECOVERY TEST - GLORIETA SANDSTONE

$$Q/s = \frac{Q/s_p}{K_p \left[1 + 7 \sqrt{\frac{r_w}{2K_p m}} \cos \frac{K_p \pi}{2} \right]}$$

where Q/s = corrected specific capacity, gpm/ft

Q/s_p = specific capacity of partially penetrating well, gpm/ft

K_p = ratio of length of penetration to saturated thickness of formation, fraction

r_w = radius of well, ft

m = saturated thickness of formation

The formation's transmissibility can be estimated from specific capacity (Walton, 1962).

$$Q/s = \frac{T}{264 \log \left(\frac{It}{2,693 r_w^2 s} \right) - 65.5}$$

where Q/s = corrected specific capacity, gpm/ft

T = transmissibility, gpd/ft

r_w = radius of well, ft

s = storage coefficient, fraction

t = time

Another approach used in this study for determining transmissibility where step test data are not available involves changes in water levels during recovery after recharge is ended. The method does not account for well losses or effects of partial penetration. Estimates of transmissibility can be made, however, by attributing loss failures found in the step tests of other wells to those apparent transmissibilities determined by the Theis Recovery Formula (Theis, 1935).

$$T = \frac{264Q}{S'} \log_{10} t/t'$$

where T = coefficient of transmissibility, gpd/ft

Q = injection rate, gpm

S' = residual change in head, ft

t = time since injection began

t' = time since injection ended

Based on the various approaches outlined above, coefficients of transmissibility were determined and are provided in Table 2.

The transmissibility coefficient for the last well was determined from data collected by the Panhandle Eastern Pipeline Company.

Variances in the data presented in Table 2 are attributable to many factors including the magnitude of losses, applicability of the collected data to the methods of calculation, and greatly to the part of the Glorieta Sandstone which was perforated. At any one location the Formation's apparent transmissibility will vary to a large extent depending upon the vertical placement of the perforated zone or zones.

A representative coefficient of transmissibility for the Glorieta Sandstone in Texas County is selected as 4,000 gpd/ft.

Another hydraulic characteristic of the Glorieta Sandstone is needed for making predictions of fluid pressure increases that will occur as a result of brine disposal into the formation. This is the "storage coefficient," and it is defined in Ground Water Hydrology (Todd, 1959) as follows:

Storage coefficient is defined as the volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of head normal to that surface. For a vertical column one foot by one foot extending through a confined aquifer the storage coefficient equals the volume of water (in cubic feet) released from the aquifer when the piezometric surface declines one foot.

For the storage coefficient to be determined in a well test such as those made in this study, pressure changes resulting from injection in the test well must be measured in an observation well that is developed in the same formation. No situation was found in Texas County where a well in the Glorieta Sandstone could be used as an observation well while a well test was being conducted. Thus, the coefficient of storage for the Glorieta cannot be derived from the well test data of this project.

Since the storage coefficient is needed and since the well test data do not provide the basis for its determination, the authors made considerable effort to arrive at a value which seems reasonable. This effort involved the examination of aquifer test data in 28 publications on ground-water resources where aquifers being reported on were under artesian conditions as is the Glorieta Sandstone. One of the publications, "Compilation of Results of Aquifer Tests in Texas" (Myers, 1969), contains 968 graphs of well tests on 484 pages. Another provides comprehensive coverage of well tests made in Colorado prior to 1965 (Wilson, 1965).

Table 2
Coefficients of Transmissibility

<u>Well</u>	<u>Transmissibility (gpd/ft)</u>
1. Robertson, Hall No. 1	5,000 ⁽¹⁾
2. Cities Service, Klingsick A-2	4,400 ⁽¹⁾
3. Cities Service, Hartman A-2	1,200 ⁽²⁾
4. Mid-American Pipeline SWD	12,400 ⁽¹⁾
	13,200 ⁽²⁾
	14,300 ⁽³⁾
Panhandle Eastern Pipeline Company	3,000 ⁽²⁾
Allendar No. 3-7	
Sec. 7, T3N, R18ECM	

(1) **Theis Recovery Formula**

(2) **Step Test**

(3) **Specific Capacity of Injection**

Based on this review and on the authors' experiences in making aquifer tests on several artesian aquifers, a storage coefficient of 0.0001 is considered as being reasonable for the Glorieta.

A major consideration in determining the pollutional potential of the Ogallala Aquifer by salt water disposal into the Glorieta Sandstone is their hydraulic relationship. This is best considered by relating the static water table of the Ogallala to the static pressure surface of the Glorieta.

A part of the tests in this study determined the pressure surface of the Glorieta by simply measuring static fluid levels in each well tested. These tests were augmented by information obtained from the Oklahoma Corporation Commission.

Water levels in the Ogallala were taken from publications of the U. S. Geological Survey.

A multiple regression analysis was made for the Ogallala water table and the Glorieta static pressure surface. This analysis determines planes for each thereby allowing a three-dimensional comparison of each. This is depicted in Figure 7. It can be seen that pressures in the Glorieta would exceed those in the Ogallala if projected to a diagonal line traversing the southeastern corner of Texas County, shown as Line A-A on Figure 2.

The information in Figure 7 can be used to determine the difference in elevation between static water level of the Ogallala and the static pressure surface of the Glorieta.

Figure 7 also shows that with the complete absence of pumping from the Ogallala or injecting into the Glorieta there can be no pollutional potential to the Ogallala except in the extreme southeastern corner of the County. This situation, of course, can be reversed by pumping, injection or the combination of each. It can also be seen that the pollutional potential decreases with distance from the southeastern corner of the County.

Figure 8 shows that hydraulically the Ogallala stands considerably above pressures within the Glorieta, particularly at distances removed from the southeast corner of the County. This relationship becomes most significant when compared with increases in pressure within the Glorieta resulting from the disposal of salt water with current injection rates. This relationship is shown in Figure 9. Pressure increases shown on Figure 9 were developed using a transmissibility of 4,000 gpd/ft and a storage coefficient of 0.0001 with the injection rates shown being continuous over a ten-year period. It can be seen that even with an injection rate of 500 bbls/day, pressure increases at 50 feet from the well will amount to about 7 feet. Those pressure increases will be greater near the well perforations due to partial penetration effects. Such effects will exist to a distance from the well of about twice the thickness of the Glorieta.

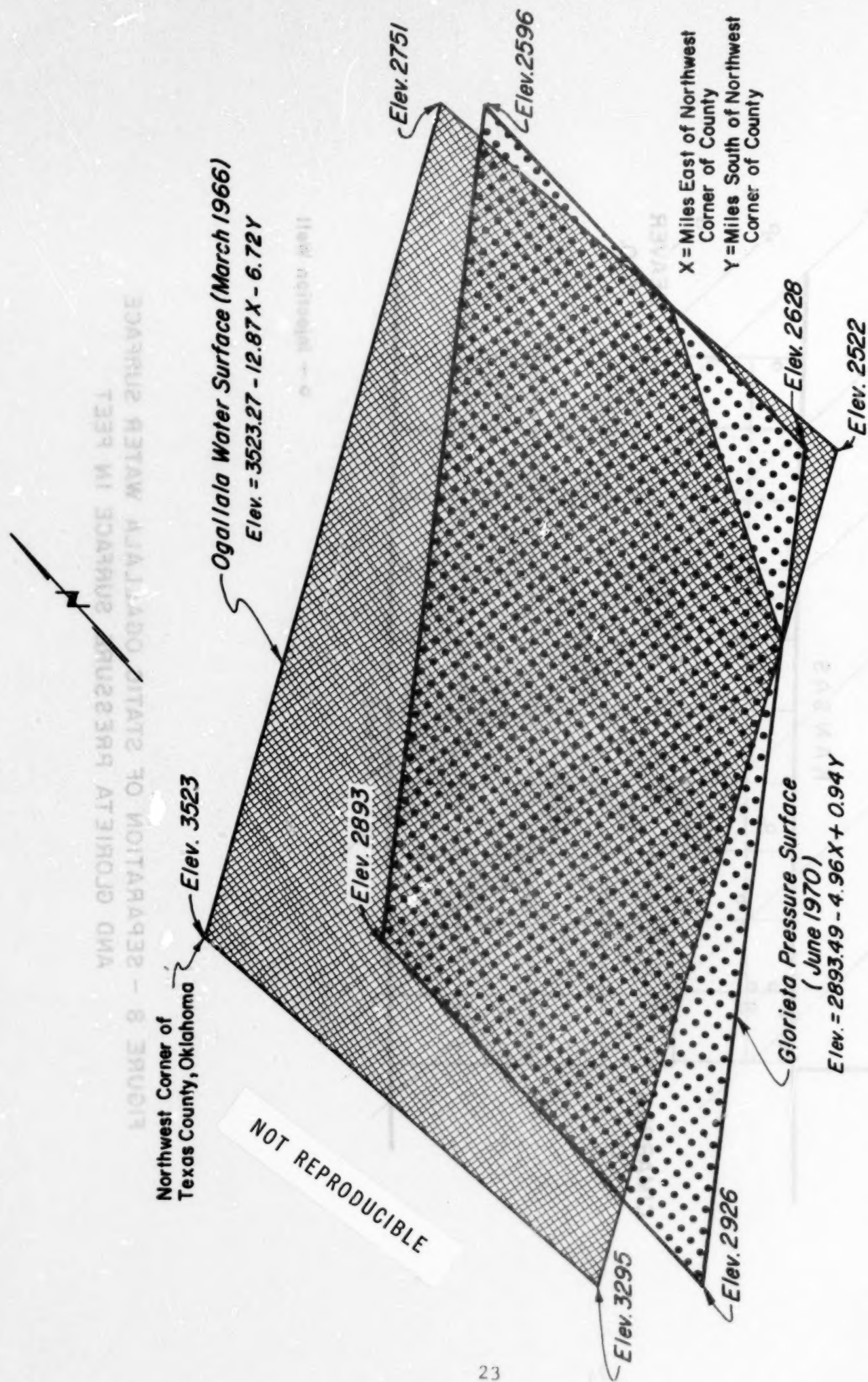


FIGURE 7 - OGALLALA - GLORIETA HYDRAULIC RELATIONSHIP
TEXAS COUNTY, OKLAHOMA

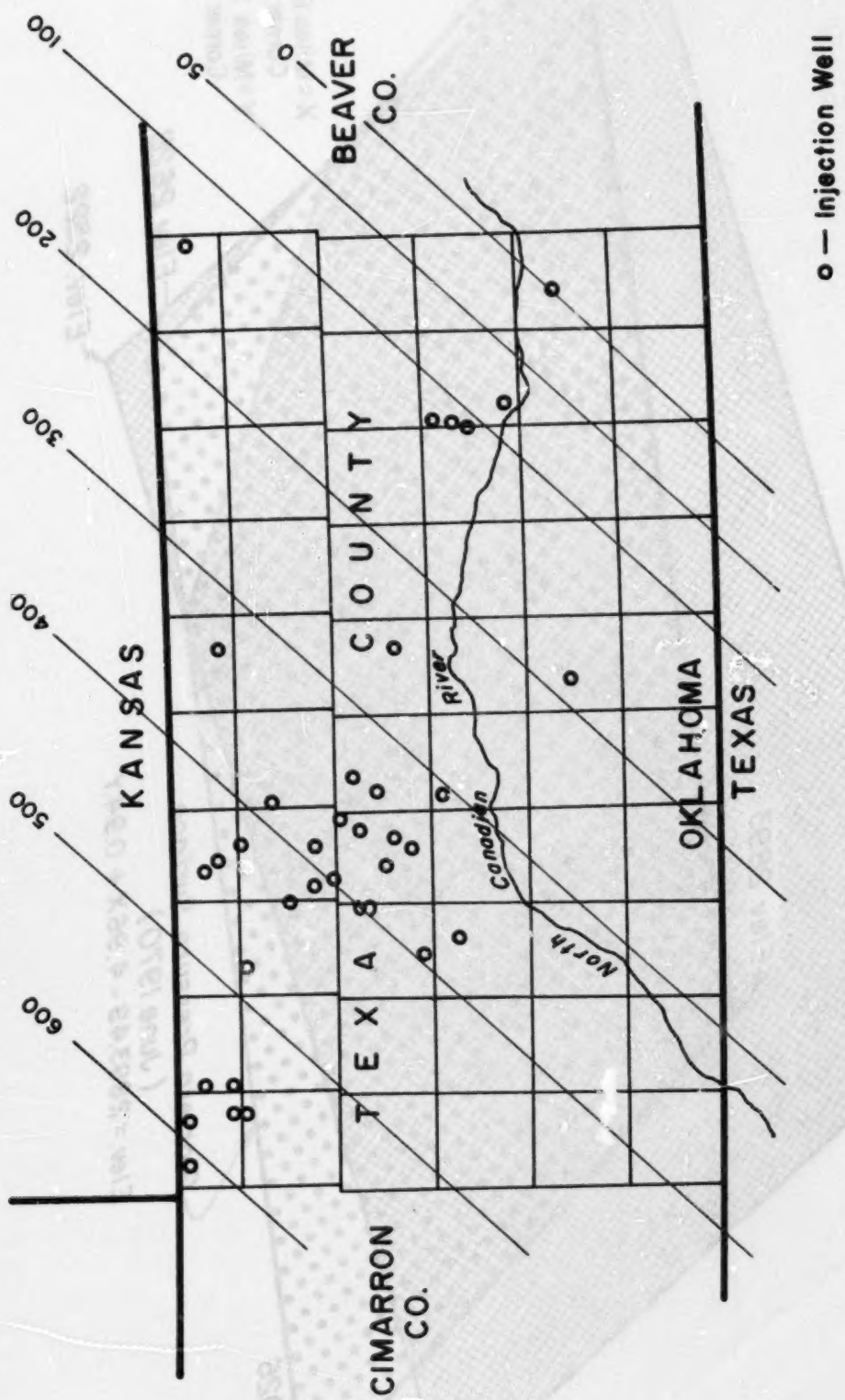


FIGURE 8 - SEPARATION OF STATIC OGALLALA WATER SURFACE AND GLORIETA PRESSURE SURFACE IN FEET

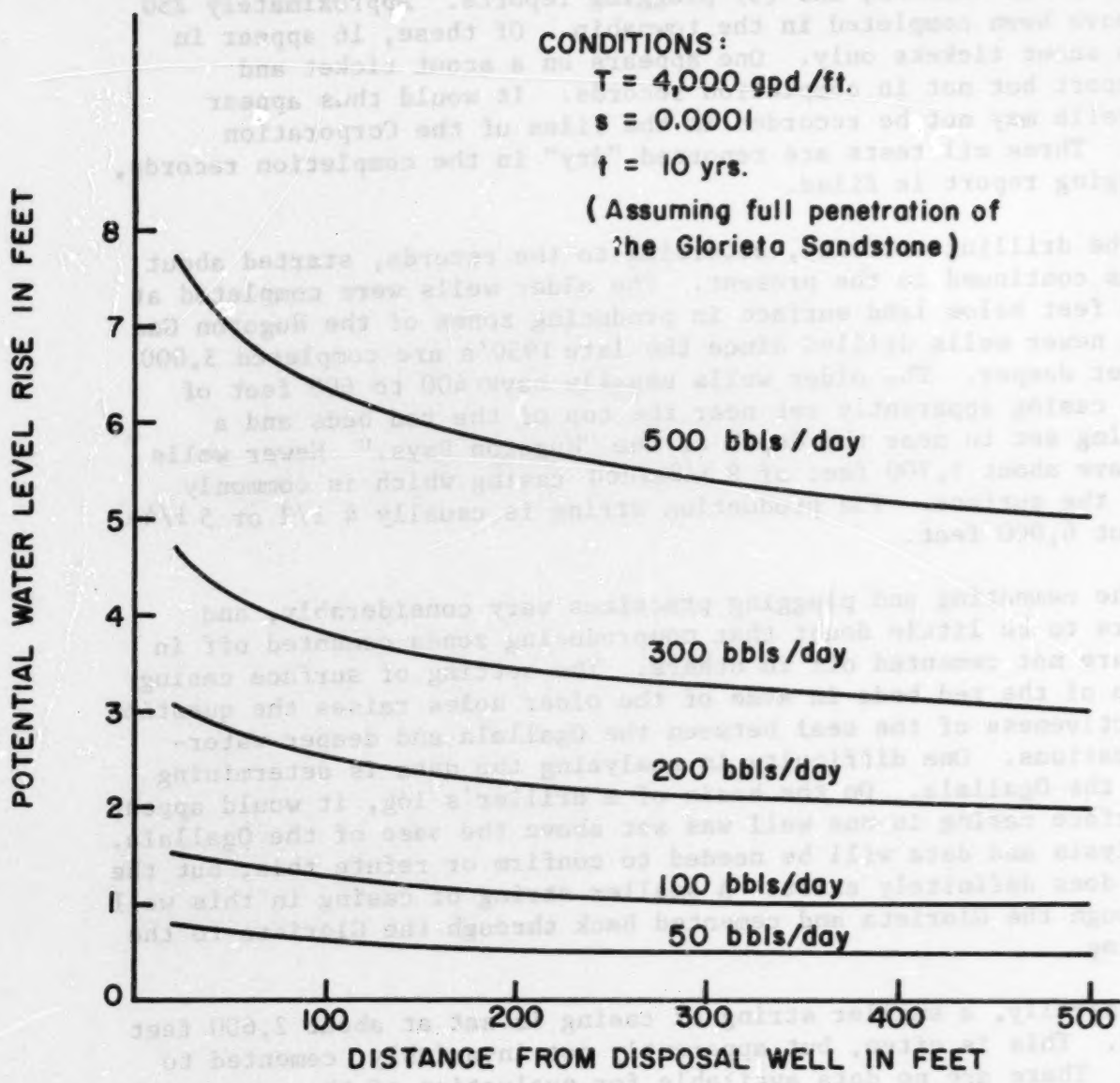


FIGURE 9 - PRESSURE INCREASES WITHIN THE GLORIETA RESULTING FROM SALT WATER DISPOSAL

Corporation Commission Records

The Corporation Commission records at the Kingfisher District Office were searched for information on oil well operation in Township T5N R13ECM in Texas County. Records examined were (1) well completion records, (2) scout tickets, and (3) plugging reports. Approximately 250 oil tests have been completed in the township. Of these, 16 appear in the file on scout tickets only. One appears on a scout ticket and plugging report but not in completion records. It would thus appear that some wells may not be recorded in the files of the Corporation Commission. Three oil tests are reported "dry" in the completion records, but no plugging report is filed.

The drilling activity, according to the records, started about 1947 and has continued to the present. The older wells were completed at about 3,000 feet below land surface in producing zones of the Hugoton Gas Field while newer wells drilled since the late 1950's are completed 3,000 to 4,000 feet deeper. The older wells usually have 400 to 600 feet of 10 3/4-inch casing apparently set near the top of the red beds and a smaller casing set to near the depth of the "Hugoton Pays." Newer wells generally have about 1,700 feet of 8 5/8-inch casing which is commonly cemented to the surface. The production string is usually 4 1/2 or 5 1/4-inch to about 6,000 feet.

The cementing and plugging practices vary considerably, and there appears to be little doubt that nonproducing zones cemented off in some wells are not cemented off in others. The setting of surface casing near the top of the red beds in some of the older holes raises the question of the effectiveness of the seal between the Ogallala and deeper water-bearing formations. One difficulty in analyzing the data is determining the base of the Ogallala. On the basis of a driller's log, it would appear that the surface casing in one well was set above the base of the Ogallala. Further analysis and data will be needed to confirm or refute this, but the possibility does definitely exist. A smaller string of casing in this well was set through the Glorieta and cemented back through the Glorieta to the surface casing.

Generally, a smaller string of casing is set at about 2,600 feet and cemented. This is often, but apparently not invariably, cemented to the surface. There are no data available for evaluation of the cement jobs so the possibility exists of connection between the Glorieta and the Ogallala. The evaluation of the situation at any given location will have to be made on the basis of all the available data for that area.

Fortunately, most of the wells drilled in the Oklahoma Panhandle are fairly new and have been constructed in accordance with good practice as to casing and cementing. Only a small percentage of the wells may cause problems.

ACKNOWLEDGMENTS

Special appreciation is expressed to Mr. Gene Teel of the Robert S. Kerr Water Research Center who designed and constructed much of the equipment that was used in the well tests. Without his ingenuous and valuable contributions, the study would have been very difficult to complete.

Excellent cooperation was received from the Mid-Continent Oil and Gas Association, the oil and gas companies, and individual disposal well owners in making arrangements for and in conducting the well tests.

Appreciation is expressed for the excellent cooperation and help given the project by the Oklahoma Corporation Commission and by the Committee for Comprehensive Studies on Fresh Water in Western Oklahoma.

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APPENDIX A. WELL TEST DATA

Table 1
Summary of Test Data

Designation and Location of Well	Land Surface Elevation (ft. above msl)	Static Fluid Level (Measured in Well)	
		Depth Below Land Surface (ft.)	Elevation (ft. above msl)
Robertson, Hall #1 Sec. 2 T5N R10ECM Texas County	3,712	787	2,925
Cities Service Klingsick A2 Sec. 22 T4N R15ECM Texas County	3,118	382	2,736
Cities Service Hartman A2 Sec. 20 T5N R13ECM Texas County	3,371	543	2,828
Mid-American Pipeline Co. Sec. 34 T6N R18ECM Texas County	2,925	309	2,616
Chris Hunt Sec. 11 T4N R8ECM Cimarron County	3,853	506*	3,347

*Note, density of water in this well was 1.07 when tested; density data for other wells are in Tables 2 through 5.

Table 2

Robertson, Hall No. 1

Sec. 2, T5N, R10ECM

June 9, 1970

<u>Time</u> (min.)	<u>Gauge</u> <u>Reading</u>	<u>Pressure</u> (psi)	<u>Head</u> (ft.)
Injection Phase: Q = 40 gpm, Density = 1.090			
15	0.578	255.7	542.1
30	0.578	255.7	542.1
45	0.579	256.2	544.2
60	0.575	254.3	539.1
75	0.575	254.3	539.1
90	0.575	254.3	539.1
105	0.575	254.3	539.1
120	0.575	254.3	539.1
135	0.586	259.4	549.9
150	0.585	258.9	548.9
165	0.585	258.9	548.9
180	0.585	258.9	548.9
195	0.585	258.9	548.9
210	0.590	261.2	553.7
225	0.590	261.2	553.7
240	0.590	261.2	553.7
Recovery Phase			
242	0.329	142.3	301.7
243	0.256	109.1	231.3
244	0.204	85.7	181.7
245	0.168	69.5	147.3
246	0.128	51.6	109.4
249	0.106	41.7	88.4
250	0.098	38.1	80.8
255	0.074	27.4	58.1
260	0.062	22.0	46.6
270	0.054	18.4	39.0
280	0.052	17.5	37.1
290	0.050	16.6	35.2
300	0.049	16.1	34.1
310	0.048	15.7	33.3
330	0.048	15.7	33.3
340	0.048	15.7	33.3
350	0.047	15.2	32.2
360	0.047	15.2	32.2
390	0.047	15.2	32.2
440	0.046	14.8	31.4
455	0.046	14.8	31.4

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Table 3

Cities Service, Klingsick A2

Sec. 22, T4N, R15ECM

June 10, 1970

<u>Time</u> (min.)	<u>Gauge</u> <u>Reading</u>	<u>Pressure</u> (psi)	<u>Head</u> (ft.)
Injection Phase: Q = 29.5 gpm, Density = 1.160			
10	0.386	168.2	334.9
15	0.442	193.6	385.5
20	0.458	200.9	400.0
30	0.471	206.8	411.7
40	0.474	208.2	414.5
50	0.473	207.8	413.7
70	0.468	205.5	409.2
80	0.466	204.6	407.4
100	0.460	201.8	401.8
110	0.456	200.0	398.2
120	0.466	204.6	407.4
130	0.473	207.8	413.7
140	0.474	208.2	414.5
150	0.474	208.2	414.5
160	0.470	206.4	410.9
170	0.467	205.0	408.2
190	0.460	201.8	401.8
210	0.452	198.2	394.6
230	0.443	194.1	386.5
240	0.441	193.2	384.7
Recovery Phase			
245	0.274	117.3	233.5
250	0.213	89.7	178.6
255	0.185	77.1	153.5
260	0.170	70.4	140.2
266	0.162	66.8	133.0
270	0.160	65.9	131.2
280	0.157	64.6	128.6
290	0.155	63.7	126.8
300	0.155	63.7	126.8
340	0.155	63.7	126.8
390	0.154	63.2	125.8
414	0.154	63.2	125.8
450	0.154	63.2	125.8
480	0.154	63.2	125.8

Table 4

Cities Service, Hartman A2

Sec. 20, T5N, R13ECM

June 12, 1970

<u>Time</u> (min.)	<u>Gauge</u> <u>Reading</u>	<u>Pressure</u> (psi)	<u>Head</u> (ft.)
Injection Phase: Q = 20 gpm, Density = 1.144			
15	0.608	269.4	542.6
17	0.610	270.3	544.4
21	0.608	269.4	542.6
24	0.607	268.9	541.6
27	0.612	271.2	546.2
30	0.612	271.2	546.2
40	0.603	267.1	537.9
50	0.599	265.3	534.3
63	0.598	264.8	533.3
75	0.598	264.8	533.3
79	0.597	264.4	532.5
90	0.638	283.1	570.2
105	0.640	284.0	572.0
150	0.635	281.7	567.3
180	0.642	284.9	573.8
203	0.645	286.3	576.6
250	0.661	293.6	591.3
311	0.679	301.8	607.8
330	0.685	304.5	613.3
350	0.688	305.9	616.1
360	0.689	306.3	616.9
420	0.693	308.1	620.5
Recovery Phase			
422	0.416	181.8	366.1
423	0.346	150.0	302.1
425	0.285	122.3	246.3
430	0.251	106.8	215.1
435	0.244	103.6	208.7
440	0.241	102.3	206.0
450	0.235	99.6	200.6
460	0.232	98.2	197.8
470	0.229	96.9	195.2
480	0.226	95.5	192.3
490	0.222	93.7	188.7
510	0.215	90.6	182.5

Table 4
(Continued)

Cities Service, Hartman A2
Sec. 20, T5N, R13ECM
June 12, 1970

<u>Time</u> (min.)	<u>Gauge</u> <u>Reading</u>	<u>Pressure</u> (psi)	<u>Head</u> (ft.)
Recovery Phase (Continued)			
525	0.210	88.3	177.8
540	0.206	86.5	174.2
550	0.204	85.7	172.6
560	0.200	83.9	169.0
580	0.195	81.6	164.3
600	0.189	78.9	158.9
621	0.184	76.7	154.5
650	0.179	74.4	149.8
660	0.176	73.1	147.2
670	0.174	72.2	145.4
720	0.165	68.2	137.4
Step Test 5 gpm			
2	0.246	104.5	241.4
3	0.299	128.6	297.1
4	0.341	147.7	341.2
5	0.367	159.5	368.4
6	0.382	166.4	384.4
7	0.391	170.5	393.9
8	0.396	172.7	398.9
10	0.403	175.9	406.3
11	0.404	176.4	407.5
12	0.404	176.4	407.5
13	0.402	175.5	405.4
14	0.402	175.5	405.4
15	0.402	175.5	405.4
Step Test 10 gpm			
16	0.450	197.3	455.8
17	0.484	212.8	491.6
18	0.501	220.5	509.4
19	0.503	221.5	511.7
20	0.504	221.9	512.6

Table 4
(Continued)

Cities Service, Hartman A2

Sec. 20, T5N, R13ECM

June 12, 1970

<u>Time</u> (min.)	<u>Gauge</u> <u>Reading</u>	<u>Pressure</u> (psi)	<u>Head</u> (ft.)
Step Test 10 gpm (Continued)			
21	0.507	223.3	515.8
22	0.507	223.3	515.8
23	0.508	223.7	516.7
24	0.512	225.6	521.1
25	0.514	226.5	523.2
26	0.514	226.5	523.2
28	0.513	226.0	522.1
29	0.512	225.6	521.1
30	0.512	225.6	521.1
Step Test 15 gpm			
31	0.551	243.4	562.3
32	0.578	255.7	590.7
33	0.582	257.5	594.8
34	0.584	258.4	596.9
35	0.585	258.9	598.1
36	0.585	258.9	598.1
37	0.585	258.9	598.1
38	0.585	258.9	598.1
39	0.586	259.4	599.2
40	0.586	259.4	599.2
41	0.586	259.4	599.2
42	0.586	259.4	599.2
43	0.586	259.4	599.2
44	0.586	259.4	599.2
45	0.586	259.4	599.2
Step Test 20 gpm			
46	0.618	274.0	632.9
47	0.622	275.8	637.1
48	0.622	275.8	637.1
49	0.622	275.8	637.1
50	0.622	275.8	637.1

Table 4
(Continued)
Cities Service, Hartman A2
Sec. 20, T5N, R13ECM
June 12, 1970

<u>Time</u> (min.)	<u>Gauge</u> <u>Reading</u>	<u>Pressure</u> (psi)	<u>Head</u> (ft.)
Step Test 20 gpm (Continued)			
51	0.623	276.3	638.3
52	0.624	276.7	639.2
53	0.624	276.7	639.2
54	0.624	276.7	639.2
55	0.625	277.2	640.3
56	0.626	277.2	640.3
57	0.626	277.2	640.3
58	0.626	277.2	640.3
59	0.626	277.2	640.3
60	0.627	278.1	642.4
Step Test 25 gpm			
61	0.651	289.0	667.6
62	0.654	290.4	670.8
63	0.655	290.9	672.0
64	0.657	291.8	674.1
65	0.658	292.2	675.0
66	0.659	292.7	676.1
67	0.660	293.2	677.3
68	0.662	294.1	679.4
69	0.663	294.5	680.3
70	0.664	295.0	681.5
71	0.665	295.4	682.4
72	0.665	295.4	682.4
73	0.665	295.4	682.4
74	0.665	295.4	682.4
75	0.667	296.3	684.5
76	0.668	296.8	685.6

Table 5

Mid-American Pipeline Company
Salt Water Disposal Well

Sec. 34, T6N, R18ECM

June 23, 1970

<u>Time</u> (min.)	<u>Gauge</u> <u>Reading</u>	<u>Pressure</u> (psi)	<u>Head</u> (ft.)
Injection Phase: Q = 40 gpm, Density = 1.17			
10	0.248	105.5	207.8
20	0.250	106.4	209.6
30	0.250	106.4	209.6
38	0.248	105.5	207.8
50	0.248	105.5	207.8
50	0.248	105.5	207.8
80	0.248	105.5	207.8
100	0.247	105.0	206.9
120	0.247	105.0	206.9
140	0.246	104.5	205.9
160	0.226	95.5	188.1
180	0.223	94.2	185.6
200	0.222	93.7	184.6
210	0.214	90.1	177.5
230	0.215	90.6	178.5
240	0.214	90.1	177.5
260	0.215	90.6	177.5
300	0.212	89.2	175.7
320	0.210	88.3	174.0
340	0.212	89.2	175.7
370	0.215	90.6	178.5
390	0.216	91.0	179.3
420	0.217	91.5	180.3
Recovery Phase			
422	0.099	38.6	76.0
425	0.098	38.1	75.1
430	0.097	37.7	74.3
440	0.096	37.2	73.3
450	0.096	37.2	73.3
460	0.095	36.8	72.5
480	0.095	36.8	72.5
500	0.095	36.8	72.5
520	0.095	36.8	72.5
550	0.095	36.8	72.5

Table 5
(Continued)

Mid-American Pipeline Company
Salt Water Disposal Well

Sec. 34, T6N, R18ECM

June 23, 1970

<u>Time</u> (min.)	<u>Gauge</u> <u>Reading</u>	<u>Pressure</u> (psi)	<u>Head</u> (ft.)
Recovery Phase (Continued)			
580	0.095	36.8	72.5
600	0.095	36.8	72.5
630	0.095	36.8	72.5
700	0.095	36.8	72.5
730	0.095	36.8	72.5
800	0.095	36.8	72.5
850	0.095	36.8	72.5
880	0.096	37.2	73.3
930	0.096	37.2	73.3
1000	0.096	37.2	73.3
1100	0.096	37.2	73.3
1200	0.096	37.2	73.3
Step Test 30 gpm			
5	0.148	60.5	119.2
10	0.147	60.1	118.4
15	0.150	61.4	121.0
20	0.151	61.9	121.9
25	0.151	61.9	121.9
30	0.152	62.3	122.7
40	0.152	62.3	122.7
50	0.152	62.3	122.7
60	0.153	62.8	123.7
Step Test 40 gpm			
65	0.190	79.4	156.4
70	0.190	79.4	156.4
80	0.190	79.4	156.4
90	0.192	80.3	158.2
100	0.193	80.7	159.0
110	0.194	81.2	160.0
120	0.193	80.7	159.0

Table 5
(Continued)

Mid-American Pipeline Company
Salt Water Disposal Well

Sec. 34, T6N, R18ECM

June 23, 1970

<u>Time</u> (min.)	<u>Gauge</u> <u>Reading</u>	<u>Pressure</u> (psi)	<u>Head</u> (ft.)
Step Test 50 gpm			
125	0.232	98.2	193.5
130	0.233	98.7	194.4
135	0.268	114.5	225.6
140	0.285	122.3	240.9
150	0.292	125.5	247.2
170	0.306	131.8	259.6
180	0.312	134.5	265.0
Step Test 58 gpm			
184	0.352	152.7	300.8
190	0.353	153.2	301.8
195	0.354	153.6	302.6

APPENDIX B. ABSTRACTED OKLAHOMA CORPORATION COMMISSION RECORDS

The information included in this Appendix was abstracted from the Oklahoma Corporation Commission files in Kingfisher, Oklahoma. Each well has been assigned a number which appears in the first column of the table.

The system of numbering wells and locations in this report is based on the common subdivision of public lands into townships, ranges, and sections. A number designates a well or observation point and locates its position to the nearest 10-acre tract in the land network.

The location number is divided by periods into four segments. The first segment denotes the township north of the Oklahoma base line. The second segment denotes the range east of the Cimarron meridian. The third segment indicates the number of the section within the township. The fourth segment indicates the 10-acre tract in which the well is located. The section is divided into four quarters, number 1, 2, 3, and 4, in normal reading order. The first digit of the fourth segment gives the quarter section. Similarly, the quarter section is divided into four 40-acre tracts numbered in the same manner, and the second digit denotes the 40-acre tract. Finally, the 40-acre tract is divided into four 10-acre tracts. Thus, a location numbered 10.3.24.342 would be the NE1/4 SE1/4SW1/4 Sec. 24, T. 10 N., R. 3 E. (Figure 1).

If a well cannot be located accurately to a 10-acre tract, a zero is used as the third digit of the fourth segment, and if it cannot be located accurately within a 40-acre tract, zeros are used for both the second and third digits. If it cannot be located more closely than the section, the fourth segment of the well number is omitted.

The second column is the well name with the company on the first line followed by the lease name and number on the lease.

The third column gives the distances in feet north and east of the 1/4 section lines. A few obvious exceptions are given from section lines.

The fourth column is elevation of the ground surface at the well. Where the elevation is followed by DF, the elevation is that of the derrick floor.

The fifth column is the casing record: diameter, depth set and the number of sacks of cement used.

The sixth column is the total depth as reported and is followed by the date of completion in the seventh column.

The following table is divided into three parts: the first is well records abstracted from completion reports, the second from scout tickets, and the third from plugging reports.

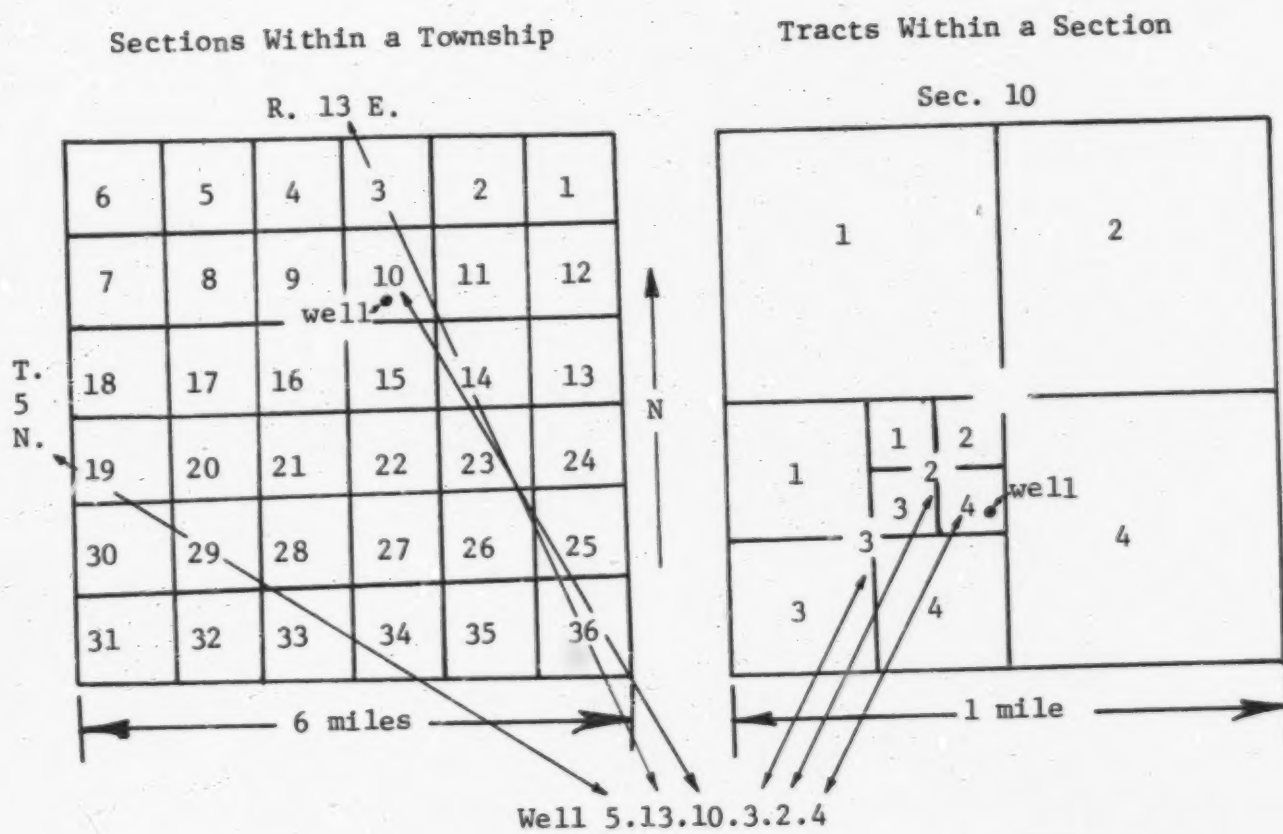


FIGURE 1 -- SYSTEM OF NUMBER WELLS IN THIS REPORT

Table 1

WELL RECORDS

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
<u>Completion Reports</u>										
5.13.1.111	Mobil	-	2335N 305E	3,347	8 5/8 4 1/2	1,761 6,240	500 150	6,325	6/22/68	Injection
5.13.1.400	Mobil	Harrison #1 (D)	660N 1980E	3,340	8 5/8 5 1/2	1,764 6,229	500 125	6,650	2/13/65	Oil
5.13.1.233	Mobil	Weeks #3	50N 300E	3,332	10 3/4 7	503 2,648	250 900	2,771	3/31/49	Gas
5.13.1.310	Mobil	Weeks #1	1980N 435E	3,342	8 5/8 4 1/2	1,747 6,630	725 500	6,582	12/8/62	Oil
5.13.1.210	Mobil	Weeks D1	1980N 660E	3,347	8 5/8 5 1/2	1,799 6,287	500 180	6,650	5/15/65	Oil
5.13.1.440	Mobil	Weeks #2	660N 1980E	3,314	8 5/8 4 1/2	1,743 6,296	800 100	6,660	6/27/64	Oil
5.13.2.110	Mobil	Lowrey #2	1980N 660W	3,346	8 5/8	1,752	800	6,675	8/14/65	Dry
5.13.2.233	Rep. Nat. Gas	Talbot #1	300N 100E	3,346	10 3/4 7	478 2,659	250 900	2,745	8/4/49	Gas
5.13.2.410	Rep. Nat. Gas	Talbot 1M	1980N 660E	3,346	8 5/8 5 1/2	2,787 6,178	1407 ¹ 260	6,645	6/18/60	Oil

¹ Circulated to surface.

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.2.340	Rep. Nat. Gas	Finfrock A #1M	660N 1980E	3,350	8 5/8 5 1/2	1,752 6,540	497 250	6,825	4/25/60	Oil
5.13.2.310	Rep. Nat. Gas	Finfrock A #2M	1980N 660E	3,352	8 5/8 5 1/2	1,764 6,650	1066 ² 250	6,684	7/20/61	Oil
5.13.2.140	Rep. Nat. Gas	Lowrey 1M	660N 1980E	3,349	8 5/8 5 1/2	1,761 6,207	925 225	6,600	4/4/61	Oil
5.13.2.110	Mobil	Lowrey #2	1980N 660E	3,346	8 5/8	1,752	800	6,675	8/24/63	Dry
5.13.2.240	Rep. Nat. Gas	Talbot 2M	660N 1980E	3,343	8 5/8 5 1/2	1,746 6,189	1456 200	6,494	3/25/61	Oil
5.13.2.210	Rep. Nat. Gas	Talbot 3M	1980N 660E	3,346	8 5/8	1,750	987	6,661	11/3/61	Dry
5.13.2.440	Rep. Nat. Gas	Talbot 4M	660N 1980E	3,347	8 5/8 5 1/2	1,771 6,450	1021 200	6,684	1/2/62	Oil
5.13.3.311	Rep. Nat. Gas	Julian SWD #1	2480N 2405E	3,356	5 1/2	1,378	138	1,400	10/3/59	Injection Slotted Casing
5.13.3.144	Rep. Nat. Gas	Julian #2	300N 2540E	3,355	10 3/4 7 5 1/2	504 2,635	300 800	2,731	6/26/50	Gas

2To surface.

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.3.411	Rep. Nat. Gas	Julian #3	2475N 2805E	3,359	7 5/8 4 1/2	2,790 6,575	900 256	6,617	7/14/58	Gas
5.13.3.140	Rep. Nat. Gas	Julian #4	660N 1980E	3,358	8 5/8 5 1/2	1,779 6,554	770 240	6,604	4/6/59	Oil
5.13.3.310	Rep. Nat. Gas	Julian #5	1980N 660E	3,363	8 5/8 5 1/2	1,775 6,544	600 212	6,660	5/15/59	Oil
5.13.3.210	Rep. Nat. Gas	Julian #6	1980N 660E	3,351	8 5/8 5 1/2	1,782 6,563	607 230	6,715	12/23/58	Oil
5.13.3.240	Rep. Nat. Gas	Julian #7	660N 1980E	3,349	8 5/8 5 1/2	1,781 6,545	1200 200	6,627	5/1/60	Oil
5.13.3.440	Rep. Nat. Gas	Julian #8	660N 1980E	3,354	8 5/8 5 1/2	1,763 6,564	1008 350	6,571	6/19/61	Oil
5.13.3.340	Mobil	Julian #9	660N 1980E	3,359	8 5/8	1,772	600	6,550	3/9/63	Dry /
5.13.3.110	Mobil	Julian #10	1980N 660E	3,362	8 5/8 5 1/2	1,754 6,600	800 175	6,675	4/12/64	Gas
5.13.4.410	Mobil	Julian #11	1980N 660E	3,376	8 5/8 5 1/2	1,760 6,651	500 1651	6,652	4/17/65	Oil
5.13.4.210	Rep. Nat. Gas	McDaniel #1M	1980N 660E	3,382	8 5/8 5 1/2	1,780 6,542	1074 ³ 500	6,675	5/1/61	Oil

³To surface.

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement		
5.13.4.140	Mobil	Langston A #1	660N 1980E	3,389	8 5/8 5 1/2	2,930 6,550	770 240	4/25/61	Lost Circulation at 1,325
5.13.4.140	Rep. Nat. Gas	Langston 1M	660N 1980E	3,389	8 5/8 5 1/2	2,930 6,550	1020 240	10/5/60	Oil
5.13.4.144	Rep. Nat. Gas	Langston #2	300N 2510E	3,385	10 3/4 7	430 2,649	250 800	12/4/50	Gas
5.13.4.140	Rep. Nat. Gas	Langston 1M	660N 1980E	3,389	8 5/8 5 1/2	2,930 6,550	240	4/25/61	Gas and Oil
5.13.4.210	Rep. Nat. Gas	McDaniel 1M	1980N 660E	3,382	8 5/8 5 1/2	1,788 6,542	1074 200	6/22/61	Oil
5.13.4.240	Mobil	McDaniel #2	660N 1980E	3,368	8 5/8 5 1/2	1,757 6,514	515 300	12/19/69	Oil
5.13.5.140	Anadarko	McDaniel A1	660N 1980E	3,404	8 5/8 4 1/2	1,748 6,183	800 175	9/28/65	Oil
5.13.5.410	Anadarko	Miller G1	1980N 1980E	3,395	8 5/8 4 1/2	1,752 6,190	800 200	12/1/64	Oil
5.13.5.322	Panhandle Eastern	Welsh 1-5	2371N 2372E	3,399	10 3/4 7	493 2,624	275 800	11/26/51	Gas
5.13.5.240	Anadarko	Wilson C1	660N 1980E	3,395	8 5/8 5 1/2	1,739 6,644	800 200	4/20/64	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.6.230	Anadarko	Haar E #1	660N 660E	3,410	8 5/8	1,757	800	6,571	3/17/64	Dry
5.13.7.233	Panhandle Eastern	Haar 17	2440N 2830E	3,404	10 3/4 7	495 2,577	275 800	2,734	10/24/52	Gas
5.13.7.320	Anadarko	Bacon A1	1980N 1980E	3,401	10 3/8 8 5/8 4 1/2	507 1,711 6,424	500 300 225	6,425	2/11/68	Dry
5.13.8.240	Anadarko	Miller F1		3,387	8 5/8	1,750	900	6,965	10/31/62	Dry
5.13.8.104	Panhandle Eastern	Tucker 2-8	3301N 1980E	3,494	13 3/8 9 5/8 5 1/2	508 2,657 5,989	400 400 400	6,150	5/1/56	Oil and Gas
5.13.9.340	Mobil	Fischer 1	660N 1980E	3,348	8 5/8 4 1/2	1,763 6,412	1100 375	6,400	9/7/62	Oil
5.13.9.411	Rep. Nat. Gas	Welch #1	2340N 100E	3,371	10 3/4 7	524 2,634	300 850	2,739	6/17/50	Gas
5.13.9.410	Rep. Nat. Gas	Welch 1M	1980N 660E	3,369	8 5/8 5 1/2	1,771 6,655	496 450	6,700	1/27/61	Oil
5.13.9.440	Mobil	Welch 2	660N 1980E	3,359	8 5/8 4 1/2	1,755 6,433	700 350	6,420	5/2/63	Oil and Gas

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.9.240	Rep. Nat. Gas	Weeks-Welch 3M	660N 1980E	3,362	8 5/8 5 1/2	1,756 6,585	1007 373	6,700 6,672	8/14/61	Oil
5.13.9.210	Rep. Nat. Gas	Weeks-Welch 4M	1980N 660E	3,375	8 5/8	1,788	1182		11/3/61	Dry, Filled with Mud
5.13.9.140	Rep. Nat. Gas	Wilson A 1M	660N 1980E	3,378	8 5/8 5 1/2	1,767 6,237	608 275	6,695	9/11/61	Oil
5.13.10.322	Rep. Nat. Gas	Hitch #1	2340N 2340	3,352	10 3/4 7	508 2,654	250 900	2,748	5/27/50	Gas
5.13.10.140	Rep. Nat. Gas	Weeks A 1M	660N 1980E	3,355	8 5/8 5 1/2	2,904 6,427	1781 ⁴ 295	6,676	12/20/60	Gas
5.13.10.240	Rep. Nat. Gas	Weeks A 2M	660N 1980E	3,358	8 5/8 4 1/2	1,747 6,537	1010 573	6,676	5/29/61	Gas
5.13.10.310	Mobil	Weeks-Welch 5	1980N 660E	3,357	8 5/8 4 1/2	1,760 6,658	600 550	6,560	5/23/63	Oil and Gas
5.13.10.410	Mobil	Wilson #1	1980N 660E	3,351	8 5/8 4 1/2	1,777 6,570	675 350	6,700	2/25/63	Oil
5.13.11.411	Rep. Nat. Gas	Blake #2	2340N 80E	3,349	10 3/4 7	425 2,652	200 800	2,756	10/18/50	Gas
5.13.11.140	Rep. Nat. Gas	Blake #3	680N 1980E	3,351	8 5/8 5 1/2	2,763 6,450	693 338	6,851	5/13/59	Oil

⁴To surface.

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.11.410	Rep. Nat. Gas	Blake #4	1980N 660E	3,339	8 5/8 5 1/2	1,768 6,439	566 356	6,693	8/10/59	Gas
5.13.11.110	Rep. Nat. Gas	Blake 5M	1980N 660E	3,352	8 5/8 5 1/2	1,786 6,238	450 275	6,675	2/14/60	Oil
5.13.11.210	Rep. Nat. Gas	Blake 6M	1980N 660E	3,345	8 5/8 5 1/2	2,878 6,399	713 ⁵ 252	8,200	9/23/60	Oil
5.13.11.310	Rep. Nat. Gas	Swenson #2	1980N 660E	3,352	8 5/8 5 1/2	1,441 6,427	1298 ⁵ 282	6,660	7/31/59	Oil
5.13.12.420	Mobil	Hough Morrow A Unit #31	1982N 1982E	3,311	8 5/8 5 1/2	1,735 6,279	550 125	6,280	11/13/69	Oil
5.13.12.100	Mobil	Hough Morrow A Unit #3	1321N 658E		8 5/8 5 1/2	1,756 6,255	480 125	6,256	8/13/69	Oil
5.13.12.411	Rep. Nat. Gas	Hillier #2	2625N 300E	3,218	10 3/4 7	428 2,633	200 800	2,743	10/9/50	Gas
5.13.12.240	Mobil	Hillier B1	660N 1980E	3,313	8 5/8 4 1/2	1,740 6,201	800 100	6,633	3/6/64	Oil
5.13.12.440	Mobil	L. Hillier #1	660N 1980E	3,312	8 5/8 5 1/2	1,741 6,592	600 350	6,600	6/5/63	Oil and Gas
5.13.12.410	Mobil	L. Hillier #2	1980N 660E	3,313	8 5/8 5 1/2	1,736 6,697	600 350	6,700	8/24/63	Oil and Gas

⁵To surface.

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.12.340	Mobil	Weeks B #1	660N 1980E						9/21/69	Oil - Workover
5.13.12.340	Mobil	Weeks B #1	660N 1980E	3,324	8 5/8 5 1/2	1,743 6,625	800 400	6,962	10/8/63	Oil and Gas
5.13.13.340	Rep. Nat. Gas	Ferguson 1M	660N 1980E	3,319	8 5/8 5 1/2	1,782 6,677	1069 ⁶ 320	6,685	9/22/60	Oil and Gas
5.13.13.310	Rep. Nat. Gas	Ferguson 2M	1980N 660E	3,328	8 5/8	1,749	470	6,740	2/20/60	Dry
5.13.13.213	Mobil	Hough Morrow A Unit 2 (WSW)	1450N 608E		9 5/8 7	1,745 4,400	450 200	4,365	2/21/68	Water Supply Well
5.13.13.240	Mobil	H. Hiller A #2	660N 1980E	3,314	8 5/8 5 1/2	1,767 6,447	1100 425	6,700	8/30/62	Oil
5.13.13.210	Mobil	Hillier A #3	1980N 660E	3,318	8 5/8 5 1/2	1,762 6,324	600 275	6,640	4/14/63	Oil
5.13.13.233	Rep. Nat. Gas	Hillier #1	50N 300E	3,318	10 3/4 7	450 2,699	250 900	2,790	8/2/48	Gas
5.13.13.140	Rep. Nat. Gas	Hillier A 1M	660N 1980E	3,323	8 5/8 5 1/2	1,777 6,600	636 340	6,670	11/28/59	Oil

⁶To surface.

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.13.210	Mobil	Hough Morrow A Unit (WSW)	1980N 668E		16 16	120 249	To surface	390		37,500 BWD
5.13.13.310	Mobil	Hough Morrow A Unit #16			4 1/2	6,357	175 To surface			Water Injection Redrill Plug-Back to 6,300
5.13.13.113	Mobil	Hiller A #4	1905N 585E	3,329	8 5/8 5 1/2	1,753 6,601	750 300	6,640	10/14/63	Gas
5.13.13.233	Cities Service	Schoonover A1	330N 330E	3,513	8 5/8 5 1/2	1,592 2,537	850 550	6,300	6/17/58	Gas
5.13.13.440	Rep. Nat. Gas	Welch #2	660N	3,313	8 5/8	2,876	1100 To surface	7,069	10/17/59	Oil
5.13.13.410	Rep. Nat. Gas	Welch #3	1980N 660E	3,317	5 1/2 13 3/8 8 5/8 5 1/2	6,668 518 1,779 6,601	250 320 175	6,717	6/14/59	Oil
5.13.14.233	Rep. Nat. Gas	Ferguson #1	300N 100E	3,333	10 3/4 7	415 2,644	200 800	2,750	11/3/50	Gas
5.13.14.334	Samedan Oil	Gloden Unit #1	520N 1320E	3,339	8 5/8	1,788	800	6,698	6/28/68	Dry
5.13.14.140	Mobil	Ferguson #2	660N 1980E	3,336	8 5/8 5 1/2	1,752 6,686	600 250	6,627	7/7/65	Gas

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.15.410	Mobil	Clinking- beard #1	1980N 660E	3,355	8 5/8 4 1/2	1,762 6,250	515 300	6,650	8/3/64	Dry
5.13.15.310	Mobil	Mitchell #1	1980N 660E	3,366	13 5/8 8 5/8 4 1/2	532 1,779 6,431	350 400 450	6,450	9/10/63	Oil
5.13.15.110	Mobil	Wilson B1	1980N 660E	3,361	8 5/8 4 1/2	1,761 6,232	600 350	6,400	7/21/63	Oil
5.13.15.233	Rep. Nat. Gas	Wilson 1	300N 100E	3,351	10 3/4 7	423 2,657	200 800	2,750	11/6/50	Gas
5.13.16.310	Cities Service	Blauser A1	1980N 660E	3,362	8 5/8 5 1/2	1,751 6,307	700 121	6,695	5/27/63	Oil
5.13.16.340	Cities Service	Blauser A2	660N 1980E	3,350	8 5/8 5 1/2	1,748 6,447	700 300	6,625	7/26/64	Oil
5.13.16.210	Cities Service	Findlay A #1	1980N 660E	3,357	8 5/8 4 1/2	1,739 6,370	600 250	7,015	3/14/63	Oil
5.13.16.140	Cities Service	Findlay A #2	660N 1980E	3,360	8 5/8 5 1/2	1,730 6,270	700 300	6,880	4/20/63	Oil
5.13.16.240	Cities Service	Findlay A #3	660N 1980E		8 5/8 5 1/2	1,759 6,291	700 250	6,700	6/14/63	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.16.110	Cities Service	Findlay A #4	1980N 660E	3,359	8 5/8 4 1/2	1,744 6,343	700 150	6,460	11/14/65	Dry
5.13.16.440	Cities Service	Mitchell A2	660N 1980E	3,359	8 5/8 5 1/2	1,755 6,249	700 150	6,250	9/2/63	Oil
5.13.16.410	Cities Service	Mitchell A1	1980N 660E	3,358	8 5/8 5 1/2	1,761 6,440	700 370	6,690	7/27/63	Oil
5.13.17.410	Cities Service	Hiser B1	1980N 660E	3,372	8 5/8	1,752	750	7,023	9/16/63	Dry
5.13.17.411	American Gas	Hiser #1	2540N 2740E	3,376	8 5/8 5 1/2	284 2,768	200 200	2,775	2/13/51	Gas
5.13.17.440	Cities Service	Hiser B #2	660N 1980E	3,368	8 5/8 2 7/8	1,753 6,352	700 225	6,388	10/5/65	Gas
5.13.18.411	American Gas	Gloden A #1	2540N 100E	3,401	8 5/8 5 1/2	468 2,709	200 550	2,715	7/25/51	Gas
5.13.18.440	Hamilton Bros.	Gloden #1-18	658N 1980E	3,389	7 5/8 4 1/2	2,780 6,454	960 250	6,455	6/22/64	Oil
5.13.18.340	Hamilton Bros.	Sharp #1-18	660N 1980E	3,399	8 5/8 4 1/2	1,812 6,381	700 200	6,381	8/31/65	Oil
5.13.18.410	Hamilton Bros.	Gloden 2-18	1980N 660E	3,391	7 5/8	2,778	750	6,300	3/15/65	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.19.310	Cities Service	Schmalfeldt A3	1980N 660E	3,395	8 5/8 4 1/2	1,733 5,600	700 200	6,200	12/21/67	Oil
5.13.19.440	Cities Service	Hicks D #1	660N 1980E	3,381	8 5/8 5 1/2	1,674 6,398	700 420	6,424	6/30/63	Oil
5.13.19.400	Cities Service	Hicks D #2	1320N 810E	3,367	8 5/8 5 1/2	1,709 6,363	700 210	6,364	9/5/65	Oil
5.13.19.110	Cities Service	Hicks E3	1980N 660E	3,394	8 5/8 4 1/2	1,723 6,229	1225 175	6,230	9/1/66	Dry
5.13.19.440	Cities Service	Hicks D1	660N 1980E	3,381	8 5/8 4 1/2	1,674 6,398	700 420	6,424	2/18/64	Oil and Gas
5.13.19.240	Cities Service	Hicks E1	660N 1980E	3,382	8 5/8 5 1/2	1,729 6,348	700 200	6,349	2/9/65	Oil
5.13.19.130	Cities Service	Hicks E4	660N 660E	3,395	8 5/8 4 1/2	1,732 5,574	800 175	5,575	3/20/69	Oil
5.13.19.340	Cities Service	Schmalfeldt A1	660N 1980E	3,379	8 5/8	1,720	800	6,450	8/4/63	Dry
5.13.19.330	Cities Service	Schmalfeldt A2	660N 660E	3,384	8 5/8 5 1/2	1,717 6,200	700 275	6,440	8/15/67	Oil
5.13.19.411	American Gas	Steel A1	2540N 100E	3,384	8 5/8 5 1/2	360 2,718	200 625	2,725	6/17/51	Gas

7 Pulled to 3,030.

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.19.140	Cities Service	Steel A2	660N 1980E	3,387	8 5/8 4 1/2	1,724 6,150	300 1000	6,515	8/2/60	Dry
5.13.20.210	Cities Service	Cavett A1	1980N 660E	3,374	8 5/8 4 1/2	1,761 6,269	700 300	6,650	7/20/63	Gas
5.13.20.242	Cities Service	Cavett A2	940N 1650E	3,370	8 5/8	1,769	700	6,350	2/4/64	Dry
5.13.20.230	Cities Service	Cavett A3	660N 560E	3,377	8 5/8 4 1/2	1,762 6,349	700 150	6,350	9/30/66	Oil
5.13.20.110	Cities Service	Gloden B2	1980N 660E	3,382	8 5/8 5 1/2	1,749 6,260	700 150	6,430	8/26/64	Oil
5.13.20.310	Cities Service	Hartman A1	1980N 660E	3,381	8 5/8 5 1/2	1,739 6,332	700 200	6,332	2/24/64	Oil and Gas
5.13.20.333	Cities Service	Hartman A2 (SWD)	133N 133E	3,383	4 1/2	1,539	375	1,540	1/18/65	Injection Glorieta 1194-1384
5.13.20.340	Cities Service	Hartman A3	660N 1980E	3,374	8 5/8 5 1/2	1,731 6,327	700 200	6,338	4/13/65	Oil and Gas
5.13.20.410	Cities Service	Hinds D1	1980N 660E	3,372	8 5/8 5 1/2	1,724 6,320	600 300	6,737	4/13/63	Oil
5.13.20.411	American Gas	Hinds A A1	2540N 100E	3,378	8 5/8 5 1/2	466 2,754	200 550	2,760	7/23/51	Gas

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.20.440	Cities Service	Hinds D2	660N 660E	3,374	8 5/8	1,766	700	6,403	7/9/63	Dry
5.13.21.140	Cities Service	Blauser C1	660N 1980E	3,355	8 5/8 4 1/2	1,753 6,404	700 200	6,405	8/16/65	Oil
5.13.21.110	Cities Service	Blauser B1	1980N 660E	3,369	8 5/8 4 1/2	1,765 6,350	700 320	6,400	8/4/63	Gas
5.13.21.410	An. Son Corp.	Coppock 1	1980N 660E	3,335	8 5/8 4 1/2	1,741 6,227	700 175	6,230	8/4/67	Oil
5.13.21.310	Cities Service	Coppock B1	1980N 660E	3,359	8 5/8 5 1/2	1,766 6,420	700 240	6,846	6/4/63	Oil
5.13.21.411	American Gas	Coppock A1	2540N 100E	3,458	8 5/8 5 1/2	360 2,754	200 550	2,760	8/18/52	Gas
5.13.21.210	Cities Service	Stewart B1	1980N 810E	3,341	8 5/8 5 1/2	1,739 6,354	700 200	6,983	1/30/64	Oil
5.13.21.240	Cities Service	Stewart B2	660N 1980E	3,349	8 5/8	1,747	700	6,675	7/21/64	Dry
5.13.22.210	Mobil	Steinkuehler 1	1980N 660E	3,345	8 5/8	1,746	550	6,672	9/22/69	Dry

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.22.110	Mobil	O. B. Mitchell 1	1980N 660E	3,353	13 3/8 8 5/8 4 1/2	498 1,727 6,400	600 250 150	6,438	1/20/64	Oil
5.13.22.410	Mobil	Young Pulaski 1	1980N 660E	3,341	8 5/8 5 1/2	1,740 6,445	450 175	6,406	6/16/69	Oil
5.13.22.322	Rep. Nat. Gas	Hiser 1	2340N 2560E	3,341	10 3/4 7	360 2,656	175 800	2,745	11/21/50	Gas
5.13.22.440	Rep. Nat. Gas	Witt 2M	660N 1980E	3,335	8 5/8	1,742	1020	6,700	6/11/61	Dry
5.13.22.140	Mobil	O. B. Mitchell 2	660N 1980E	3,353	8 5/8 5 1/2	1,723 6,440	550 165	6,450	3/6/69	Oil
5.13.22.300	Graham Michaelis	Hiser 1-22	1980N 1320E	3,345	8 5/8 4 1/2	1,746 6,260	750 150	6,374	9/3/68	Oil
5.13.23.320	Mobil	EM Pulaski 1	1979N 1981E	3,333	13 3/8 8 5/8	510 1,759	400 ⁸ 250	6,425	9/23/68	Dry
5.13.23.120	Samedan Oil	Carr #1	1970N 1840E	3,337	8 5/8 4 1/2	1,778 6,332	550 125	7,055	4/5/68	Oil
5.13.23.240	Mobil	Hough Morrow A 10 WIW	660N 1980E	3,333	4 1/2	6,309	125	6,310	3/12/69	Injection Workover

8 To surface.

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.23.210	Graham Michaelis	Dixon 2-23	1980N 660E	3,331	8 5/8	1,754	750	6,340	2/11/69	Dry
5.13.23.322	Rep. Nat. Gas	Witt #1	2340N 2560E	3,334	10 3/4 7	392 2,670	225 800	2,767	11/14/50	Gas
5.13.24.322	Rep. Nat. Gas	Cameron #1	2340N 2650E	3,321	10 3/4 7	487 2,740	491 900	2,780	9/27/48	Gas
5.13.24.340	Mobil	Cameron #1	660N 1980E	3,311	8 5/8 4 1/2	1,760 6,280	750 150	6,460	1/9/64	Oil
5.13.24.310	Mobil	Cameron #2	1980N 660E	3,319	8 5/8 5 1/2	1,755 6,477	475 175	6,710	1/5/65	Oil
5.13.24.210	Rep. Nat. Gas	Horner 1M	1980N 660E	3,316	8 5/8 5 1/2	1,766 6,640	391 339	6,687	3/31/60	Oil and Gas
5.13.24.210	Mobil	Horner #1	1980N 660E	3,316					3/31/60	Recompletion
5.13.24.240	Mobil	Horner #2	660N 1980E	3,311	8 5/8 5 1/2	1,754 6,612	600 350	6,685	4/20/63	Oil
5.13.24.410	Mobil	Lewis #1	1980N 660E	3,316	8 5/8 4 1/2	1,772 6,494	675 225	6,428	11/29/62	Oil
5.13.24.140	Graham Michaelis	Walter 1-24		3,319	8 5/8 4 1/2	1,635 6,313	700 200	6,558	6/10/62	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.25.410	Mobil	Armstrong #1	1980N 660E	3,296	8 5/8 5 1/2	1,746 6,645	500 200	6,646	9/30/65	Oil
5.13.25.411	Rep. Nat. Gas	Armstrong #1	2590N 100E	3,298	10 3/4 7	481 2,661	250 900	2,783	9/1/48	Gas
5.13.25.140	Mobil	Gloden #1	660N 1980E	3,302	8 5/8 5 1/2	1,746 6,639	500 155	6,640	8/8/65	Oil
5.13.25.210	Mobil	Gloden #2	1980N 664E	3,316 DF	8 5/8 5 1/2	1,749 6,639	400 240	6,680		Oil
5.13.25.340	Mobil	Gloden #3	660N 1880E	3,291	8 5/8 5 1/2	1,734 6,672	800 300	6,680	6/24/64	Oil
5.13.26.233	Rep. Nat. Gas	Delong 1	250N 110E	3,308	10 3/4 7	351 2,673	200 800	2,741	11/29/59	Gas
5.13.26.240	Mobil	Delong #1	1980N 1980E	3,305	8 5/8 4 1/2	1,766 6,267	675 350	6,479	2/14/63	Oil
5.13.26.410	Mobil	Gloden #1	1980N 660E	3,300	7 5/8 4 1/2	1,764 6,230	1000 150	6,300	5/12/62	Oil
5.13.26.440	Mobil	Gloden #3	660N 1980E	3,302	8 5/8 4 1/2	1,741 6,307	750 350	6,430	6/11/63	Oil
5.13.26.140	Rep. Nat. Gas	Jacobs 1M	660N 1980E	3,320	8 5/8 5 1/2	2,972 6,254	1454 150	7,075	11/15/60	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.26.340	Mobil	Jacobs- Gloden Unit #1	660N 1980E	3,273	8 5/8 4 1/2	1,715 6,189	1100 400	6,169	8/15/62	Oil
5.13.26.314	Mobil	Jacobs- Gloden Unit #2	1820N 960E	3,268	8 5/8 4 1/2	1,640 6,185	725 150	6,134	11/2/62	Oil
5.13.26.110	Rep. Nat. Gas	Witt 1M	1980N 660E	3,330	8 5/8 4 1/2	1,773 6,274	557 230	6,707	5/24/61	Oil
5.13.27.440	Mobil	Blake 1 (SWDW)	660N 1980E	3,316	8 5/8	1,755	725		5/10/65	Glorieta 1220-1380
5.13.27.440	Mobil	Blake 1	660N 1980E	3,316				6,470	12/7/62	
5.13.27.310	Mobil	Blake A1	1980N 660E	3,331	8 5/8 5 1/2	1,771 6,391	500 175	6,700	4/27/66	Dry
5.13.27.233	Rep. Nat. Gas	Price #1	400N 100E	3,294	10 3/4 7	336 2,640	200 800	2,711	11/30/50	Gas
5.13.27.240	Rep. Nat. Gas	Price A 1M	660N 1980E	3,314	8 5/8 5 1/2	1,761 6,652	1018 351	6,649	11/7/61	Oil
5.13.27.410	Mobil	Lunsford B2	1980N 660E	3,299 DF	8 5/8	1,733	475	4,305	8/25/64	Lost Circulation Lost Hole

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.27.110	Mobil	Blake Estate 1	1980N 660E	3,318	8 5/8	1,733	450 To surface	6,610	11/29/68	Dry
5.13.27.410	Mobil	Lunsford B 2A	1980N 660E		9 5/8	1,739	525	6,732	9/11/64	Dry
5.13.28.140	Rep. Nat. Gas	Jeffus 1	660N 1980E	3,345	8 5/8 5 1/2	2,814 6,624	900 200	6,623	5/16/59	Gas
5.13.28.140	Rep. Nat. Gas	Jeffus 1	660N 1980E	3,345	8 5/8 5 1/2	2,814 6,624	900 200	6,623	5/16/59	Dry
5.13.28.130	Mobil	Jeffus 2	660N 660E	3,350	8 5/8 4 1/2	1,760 6,233	700 100	6,425	2/23/69	Oil
5.13.28.310	Rep. Nat. Gas	Landess Estate 1M	1980N 660E	3,350	8 5/8 5 1/2	1,766 6,253	1069 To surface	6,572	10/7/61	Oil
5.13.28.340	Mobil	Landess Estate A2	660N 1980E	3,346	8 5/8 4 1/2	1,854 6,299	725 150 ft	6,570	12/27/64	Oil
5.13.28.340	Mobil	Landess Estate 2	660N 1980E	3,346	8 5/8 4 1/2	1,796 6,285	625 150	6,570	10/15/62	Oil
5.13.28.210	Mobil	Jeffus 3	1980N 510E		8 5/8	1,765	550	6,490	4/18/69	Dry
5.13.28.440	Mobil	Landess Estate 3	660N 1980E	3,331	8 5/8 4 1/2	1,752 6,668	475 225	6,670	11/30/64	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement		
5.13.29.411	Am. Gas	Bollinger A1	2540N 100E	3,366	8 5/8 5 1/2	465 2,769	200 550	2/18/51	Gas
5.13.29.440	Cities Service	Bollinger B1	660N 1980E	3,343	8 5/8 5 1/2	1,669 6,335	700 350	6/7/61	Oil
5.13.29.410	Cities Service	Bollinger B2	1980N 660E	3,357	8 5/8 4 1/2	1,699 6,360	700 400	6/27/62	Oil
5.13.29.310	Cities Service	Fowkes A1	1980N 660E	3,371	8 5/8 5 1/2	1,719 6,489	700 200	11/16/63	Gas
5.13.29.240	Cities Service	Hinds C1	660N 1980E	3,357	8 5/8 4 1/2	1,748 6,250	700 300	9/5/62	Oil
5.13.29.210	Cities Service	Hinds C2	1980N 660E	3,364	8 5/8 4 1/2	1,726 6,220	700 300	1/18/63	Oil
5.13.29.110	Cities Service	Sparks D1	1980N 660E	3,374	8 5/8 5 1/2	1,712 6,400	1000 400	8/18/63	Gas
5.13.29.140	Cities Service	Sparks D2	660N 1980E	3,366	8 5/8 4 1/2	1,727 6,250	700 200	5/21/65	Oil
5.13.30.110	Cities Service	Kear A2	4620N 660E	3,380	8 5/8 4 1/2	1,713 5,585	700 150	10/29/67	Oil
5.13.30.310	Cities Service	Dudgeon B1	1980N 810E	3,336	8 5/8 4 1/2	1,670 6,322	700 400	7/2/63	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.30.340	Cities Service	Dudgeon B2	660N 1980E	3,333	8 5/8 5 1/2	1,664 6,399	700 150	6,400	7/24/63	Oil
5.13.30.140	Cities Service	Kear A1	660N 1980E	3,355	8 5/8 5 1/2	1,687 6,397	700 240	6,398	5/18/63	Oil
5.13.30.240	Cities Service	Sparks E1	660N 1980E	3,375	8 5/8 5 1/2	1,710 6,450	1340 366	6,600	1/10/64	Gas
5.13.30.410	Cities Service	Sparks C1	2030N 660E	3,348	8 5/8 5 1/2	1,684 6,360	700 350	6,634	3/6/63	Oil
5.13.30.210	Cities Service	Sparks C2	1980N 660E	3,364	8 5/8 5 1/2	1,699 6,450	700 200	6,638	5/2/64	Oil
5.13.30.240	Cities Service	Sparks C3	660N 1980E	3,375	8 5/8 5 1/2	1,710 6,450	1340 366	6,600	8/29/63	Gas
5.13.31.411	Rep. Nat. Gas	Cities Service #7	2390N 100E	3,293	10 3/4 7	645 2,600	650 900	2,620	4/30/47	Gas
5.13.31.410	Rep. Nat. Gas	Cities Service #11	1980N 660E	3,299	8 5/8 5 1/2	2,653 6,182	1050 150	6,550	8/29/60	Oil and Gas
5.13.31.440	Rep. Nat. Gas	Cities Service 16C	560N 1905E	3,270	8 5/8 5 1/2	1,724 5,602	484 150	5,260	5/22/59	Oil
5.13.31.210	Rep. Nat. Gas	Cities Service 23	1980N 660E	3,326	8 5/8 5 1/2	1,669 5,570	1555 150	5,617	6/8/61	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement		
5.13.32.414	Rep. Nat. Gas	Cities Service SWD 1	1766N 797E	3,372	5 1/2	1,237	218 To surface	1,250	8/22/61 Bottom 93 ft. Casing Slotted
5.13.32.110	Mobil	Cities Service Ryl	1780N 660E	3,347	8 5/8 5 1/2	1,722 6,200	500 320	6,310	3/2/65 Oil
5.13.32.411	Rep. Nat. Gas	Cities Service #6	2540N 200E	3,307	10 3/4 7	601 2,671	250 900	2,690	4/30/47 Gas
5.13.32.410	Rep. Nat. Gas	Cities Service 14	1980N 660E	3,303	8 5/8 5 1/2	2,795 6,518	1050 280	6,656	4/16/59 Oil
5.13.32.310	Rep. Nat. Gas	Cities Service 18	1980N 660E	3,340	8 5/8 5 1/2	1,742 5,628	1266 85	6,650	7/23/54 Oil
5.13.32.240	Rep. Nat. Gas	Cities Service 22M	660N 1980E	3,311	8 5/8 5 1/2	1,780 6,323	642 232	6,530	2/20/60 Oil
5.13.32.210	Rep. Nat. Gas	Cities Service 25M	1980N 660E	3,350	8 5/8 5 1/2	1,780 6,320	1074 125	6,398	12/1/61 Oil
5.13.33.110	Rep. Nat. Gas	Lunsford A 1M	1980N 660E	3,350	8 5/8 5 1/2	2,848 6,210	1528 ⁹ 125 ¹⁰	6,550	7/22/60 Oil
5.13.33.111	Rep. Nat. Gas	Sparks 1	2555N 250E	3,337	10 3/4 7	347 2,659	200 800		12/11/50 Gas

⁹To surface.¹⁰To 5,700.

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.33.440	Mobil	Sparks Estate 1	660N 1980E	3,323	8 5/8 5 1/2	1,714 6,573	750 200	6,574	6/12/64	Oil
5.13.33.210	Mobil	State Tract 18 #1	2030N 660E		8 5/8 4 1/2	1,737 6,318	625 350	6,605	1/11/63	Oil
5.13.33.240	Mobil	State Tract 18 #2	660N 1980E	3,321	8 5/8 5 1/2	1,739 6,559	550 225	6,590	1/20/65	Oil
5.13.34.322	Rep. Nat. Gas	Lunsford 2	2566N 2340E	3,326	10 3/4 7	464 2,669	250 805	2,753	6/11/50	Gas
5.13.34.110	Mobil	Lunsford B3	1980N 660E	3,327	8 5/8 5 1/2	1,749 6,687	500 200	6,690	3/12/65	Oil
5.13.34.240	Mobil	Mitchell A1	660N 1980E	3,335	8 5/8 4 1/2	1,775 6,320	800 300	6,450	9/11/63	Oil
5.13.34.210	Mobil	Mitchell A2	1980N 660E	3,337	8 5/8 4 1/2	1,772 6,345	500 100	6,700	10/26/64	Dry
5.13.34.440	Mobil	Mitchell 3							7/21/66	Water Supply Conv. Plugged Back to 4,265
5.13.34.440	Mobil	Mitchell 3	660N 1980E	3,340 DF	9 5/8 7	1,779 6,398	1150 400	6,450	12/3/63	Oil
5.13.34.340	Mobil	Mitchell 4	660N 1980E	3,321	8 5/8 5 1/2	1,762 6,583	800 200	6,586	4/28/64	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.34.410	Mobil	Mitchell 5	2080N 660E	3,323	8 5/8 5 1/2	1,785 6,632	490 225	6,640	10/14/64	Oil
5.13.34.310	Mobil	Mitchell 6	1980N 660E	3,311	8 5/8 5 1/2	1,736 6,579	500 215	6,580	12/8/64	Oil
5.13.35.111	Mobil	West Hough Unit 2 (WSW)	2176N 587E		13 3/8 9 5/8 7	474 1,766 4,298	800 320 340	4,220	9/27/67	Water Supply
5.13.35.440	Mobil	West Hough Unit 68	660N 1980E	3,267	9 5/8 7	1,736 6,550	425 200	6,464	11/16/69	Oil
5.13.35.410	Mobil	Gloden 5	1980N 660E	3,297	8 5/8 4 1/2	1,746 6,300	900 300	6,450	1/30/64	Oil
5.13.35.340	Mobil	James Estate 1	660N 1980E	3,306	8 5/8 5 1/2	1,767 6,461	600 400	6,460	7/25/63	Oil
5.13.35.310	Mobil	James Estate 2	1980N 660E	3,314	9 5/8 5 1/2	1,760 6,298	800 500	6,450	8/24/63	Oil
5.13.35.144	Rep. Nat. Gas	Lunsford 1	200N 2340E	3,287	10 3/4 7	443 2,650	250 800	2,739	6/22/50	Gas
5.13.35.110	Mobil	Mitchell 1	1980N 660E	3,324	8 5/8 4 1/2	1,779 6,502	1100 375	6,710	9/24/62	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.35.140	Mobil	Mitchell 2	660N 1980E	3,280	8 5/8 4 1/2	1,720 6,250	625 500	6,400	1/13/63	Oil
5.13.35.240	Mobil	Cloden 4	660N 1980E	3,252	8 5/8 5 1/2	1,704 6,300	800 125	6,450	3/13/64	Oil
5.13.36.411	Rep. Nat. Gas	Gloden 1	2540N 200E	3,288	10 3/4 7	466 2,682	250 800	2,752	6/14/50	Gas
5.13.36.110	Mobil	Gloden 1	1980N 660E	3,267	8 5/8 4 1/2	1,714 6,310	600 350	6,460	7/14/63	Oil
5.13.36.310	Mobil	Gloden 2	1980N 660E	3,235	8 5/8 4 1/2	1,689 6,269	900 125	6,625	4/23/64	Oil
5.13.36.210	Mobil	Gloden 4	1980N 660E	3,288	8 5/8 5 1/2	1,737 6,523	500 150	6,660	2/5/55	Oil
5.13.36.410	Mobil	Gloden 5	1980N 660E	3,284	8 5/8 5 1/2	1,736 6,329	800 100	6,675	8/7/64	Oil
5.13.36.140	Mobil	Hough Morrow 67	660N 1976E	3,252	8 5/8 7	1,704 6,460	700 200	6,497	11/24/69	Oil
5.13.36.340	Mobil	West Hough Morrow 69	660N 1982E	3,251	9 5/8 7	1,704 6,449	650 150	6,410	11/30/69	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
Scout Tickets										
5.13.4.310	Mobil	Julian 12			8 5/8 5 1/2	1,766 6,607	150 380	6,433	4/21/66	
5.13.6.144	Panhandle Eastern	Shiblum 1-6	2440S 2490E		10 3/4 6 5/8	505 2,584		2,757	11/20/52	
5.13.8.144	Panhandle Eastern	Shattuck 1-8	2440S 2440E	3,397 DF	10 3/4 7	488 2,575		2,772	6/19/54	Gas
5.13.16.411	Am. Gas	Hamson 1			8 5/8 5 1/2	358 2,770		2,715	7/19/51	Gas
5.13.17.411	Am. Gas	Kiser 1		3,377	8 5/8 5 1/2	285 2,768		2,770	3/8/51	Gas
5.13.17.310	Cities Service	State P1			8 5/8 4 1/2	1,752 6,315	700 450	6,884	12/23/64	
5.13.19.400	Cities Service	Hicks D2	1320N 810E		8 5/8 5 1/2	1,709 6,363	700 126	6,364	9/16/65	Oil
5.13.19.210	Cities Service	Hicks E2			8 5/8 5 1/2	1,732 6,252	900 200	6,253	1/27/66	Oil
5.13.19.310	Cities Service	Schmalfeldt A3			8 5/8 4 1/2	1,733 5,600	700 200	6,200	1/4/68	Oil

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.20.140	Cities Service	Gloden B1		3,385 DF	8 5/8 5 1/2	1,711 6,250	700 150	6,624	5/28/64	Oil
5.13.28.411	Rep. Nat. Gas	Landers 1		3,346	13 3/8 7	367 2,630		2,752	2/22/51	Gas
5.13.30.322	Am. Gas	Dudgeon A1		3,445	8 5/8 5 1/2	458 2,649		2,649	8/23/51	Gas
5.13.31.321	Mobil	S Hovey U20	2074N 1426E	3,328 DF	13 3/8 8 5/8 5 1/2	405 1,610 5,998	575	6,355	3/17/66	Oil
5.13.34.140	Mobil	Lunsford A2		3,351 DF	8 5 1/2	1,766 6,330	1200 150	6,527	8/23/62	Oil
5.13.34.140	Mobil	Lunsford B1		3,334 DF	8 5/8 4 1/2	1,759 6,650	800 150	6,650	7/23/64	
5.13.35.210	Mobil	Gloden 2		3,274 DF	8 5/8 4 1/2	1,722 6,945	675 350	6,450	6/6/63	
<u>Plugging Records</u>										
5.13.2.110	Mobil	Lowrey #2			8 5/8	1,752	50 5650 185 3000 15 40	6,675	8/15/63	

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.2.210	Rep. Nat. Gas	G. Talbot 3M			8 5/8	1,751	175 3028- 2400 50 1870- 1650 5 surf.	6,661	11/3/61	
5.13.3.340	Mobil	H. E. Julian 9			8 5/8	1,772	20 6380 20 6160 325 3000 10 50	6,650	3/9/63	
5.13.6.230	Anadarko Prod.	Haar El			8 5/8	1,757	25 6509 50 2948 50 1757 15 5	6,571	3/17/64	
5.13.7.320	Anadarko Prod.	Bacon Al			13 3/8 8 5/8 4 1/2	507 1,711 6,424	25 5834 80 550- 450 30 30-0	6,425	3/7/68	1293 ft. pulled 5218 ft. pulled
5.13.8.240	Anadarko Prod.	Miller Fl			8 5/8	1,750	25 6965 125 2950- 2553 30 1798- 1700 15 51-5	6,965	10/31/62	

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement		
5.13.9.210	Rep. Nat. Gas	Weeks-Welch 4M			8 5/8	1,788	200 2950- 2300 50 1855- 1705 5 2 1/2	11/3/61	
5.13.13.310	Rep. Nat. Gas	Ferguson 2M			8 5/8	1,764	20 6222- 6152 95 2900- 2525 50 1823- 1705	2/20/60	
5.13.15.410	Mobil	Mamie Clinkugeard			8 5/8 4 1/2	1,762 6,250	50 2826 50 1762 20-0	8/13/64	Pulled 2,826
5.13.16.110	Cities Service	Findlay A4			8 5/8 4 1/2	1,744 6,343	2 6152- 6170 40 1677- 1750 10 30-4	1/14/65	Pulled 2,619
5.13.17.410	Cities Service	Hiser B1			8 5/8	1,752	40 6540- 6650 40 6190- 6280 25 1682- 1762	9/16/63	10 sacks of cement 33-4

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.17.310	Cities Service	State P1			8 5/8 4 1/2	1,752 6,315	110 6155- 6157 40 1677- 1800 10 30-4	6,680	12/15/64	Pulled 2,626
5.13.19.340	Cities Service	Schmalfeldt A1			8 5/8	1,720	75 6064- 6200 25 5977- 6064 50 2526- 2700 10 4	6,450	8/5/63	
5.13.19.140	Cities Service	Steel A2			8 5/8 4 1/2	1,724 6,150	25 4920 20-4	6,515	10/10/60	Pulled 3,620
5.13.19.110	Cities Service	Hicks E3			8 5/8 4 1/2	1,723 6,229	110 6025- 6085 50 2578- 2726 35 1760- 1770 10 30-4	6,230	9/1/66	Pulled 3,030
5.13.20.242	Cities Service	Cavaett A2			8 5/8	1,769	100 5930- 6300 20 1678- 1748	6,350	2/21/64	10 sacks of cement 30-4

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.20.440	Cities Service	Hinds D2			8 5/8	1,766	50 6175- 6275	6,403	7/9/63	
							50 2650- 2800			
							25 1650- 1770			
							10 5 in.			
5.13.21.240	Cities Service	Stewart B2			8 5/8	1,747	25 6345- 6420	6,675	7/21/64	
							50 6118- 6250			
							20 1700- 1767			
							5 4			
5.13.22.440	Rep. Nat. Gas	H. L. Witt 2M			8 5/8	1,775	200 2900- 2600		6/10/61	
							50 1775			
5.13.23.240	Graham Michaelis	Dixon 1-23			8 5/8	1,763	50 6300	6,300	5/24/66	
							50 3000			
							35 1761			
							15 30			

Table 1

WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.27.440	Mobil	C. A. Blake 1			8 5/8	1,754	200 2377- 3011 50 1621- 1795 4 2	6,280	12/7/62	
5.13.27.410	Mobil	Lunsford B2			8 5/8	1,733	50 2703 50 1734	4,305	8/12/64	
5.13.27.410a	Mobil	Lunsford B2A			9 5/8	1,739	50 6725 60 1739			
5.13.23.210	Graham Michaelis	Dixon 2-23			8 5/8	1,754	355 6340 50 1500 15 40		2/12/69	
5.13.23.320	Mobil	Elda Mae Pulaski 1			13 3/8 8 5/8	510 1,759	50 6325- 6200 40 1827- 1700 10 30-0		9/23/68	
5.13.14.334	Samedan	Gloden Unit 1			8 5/8	1,788	50 6680 35 1835 15 Top		6/29/68	

Table 1
WELL RECORDS
(Continued)

Well Number	Well Name		Location in 1/4 Section	Elevation	Casing Record			Total Depth	Date	Remarks
	Company	Leasee			Diameter	Depth	Sacks of Cement			
5.13.7.320	Anadarko Prod.	Bacon Al			13 3/8	507	25 5834			Pulled 1,293 Pulled 5,218
					8 5/8	1,711	80 550- 450			
					4 1/2	6,424	30 30-0			
5.13.28.210	Mobil	Jeffus 3			8 5/8	1,765	55 6150- 6320		4/18/69	
							30 1700- 1800			
							15 35-0			
5.13.27.110	Mobil	Blake Estate #1			8 5/8	1,733	35 6200- 6100		11/29/68	
							35 5100- 5000			
							35 1750- 1650			
5.13.22.210	Mobil	Steinkuhler 1			8 5/8	1,746	15 20 - surface		9/21/69	
							50 6200			
							50 1775 10 35			

APPENDIX C. FEDERAL WATER QUALITY ADMINISTRATION
POLICY ON DISPOSAL OF WASTES BY
SUBSURFACE INJECTION

The disposal and storage of liquid waste by subsurface injection is being increasingly considered, especially by industries facing enforcement of water quality standards, because of the diminishing capabilities of surface waters to receive effluents without violation of standards, and because of the apparent lower costs of this method of disposal over conventional and advanced waste treatment techniques.

Improper injection of municipal or industrial wastes to the subsurface could result in a serious pollution of water supplies or in other environmental hazards. The effects of underground pollution and the fate of injected materials are uncertain with today's knowledge. Because of this, all proposals to use this method of waste disposal must receive careful scrutiny from the standpoint of environmental impact. Subsurface disposal or storage should, at no time, be authorized simply because it may appear to be the easiest and least expensive alternative for the waste producer. It could well result in serious pollution damage and require a more complex and more costly solution on a long term basis.

FWQA is opposed to the disposal or storage of wastes by subsurface injection, without strict controls and a clear demonstration that such wastes will not interfere with present or potential use of subsurface water supplies, contaminate interconnected surface waters, or otherwise damage the environment. Controlled subsurface injection may be acceptable where: (1) It has been clearly demonstrated to be the best waste disposal alternative in terms of overall environmental protection. Subsurface injection should be recognized as an essentially temporary solution, subject to development of better alternatives, and is to be minimized in its use for the disposal or storage of wastes wherever possible. (2) It is utilized in connection with overall planned management of ground water or related resources. Examples are return of oil brines for purposes of secondary oil recovery and preventing saltwater intrusion, and injection of renovated wastewater for the purpose of water reuse.

In all cases where subsurface injection is being considered, the following conditions should be assured prior to development: (1) that alternative measures have been explored and found less satisfactory in terms of environmental protection, (2) that appropriate pre-injection tests have been made to allow prediction of the fate of wastes to be injected, (3) that there is adequate evidence to demonstrate that such injection will not interfere with present or potential use of water resources or result in other environmental hazards, (4) that best practicable measures for pretreatment of wastes have been applied, (5) that the subsurface injection system has been designed and constructed using the best available techniques, equipment, and design criteria, (6) that provisions for adequate and continuous monitoring of the injection operation and resulting effects of the injection on the environment have been made, (7) that appropriate provision will be made for plugging such wells at horizons below present or potential sources of water supply when their use for disposal is discontinued.

FWQA will apply this policy to the extent of its authorities in conducting all program activities, including regulatory activities, research and development, control of pollution from Federal installations, technical assistance to the States, and the administration of the construction grants, State program grants and basin planning grants programs.